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ARMY ORDNANCE

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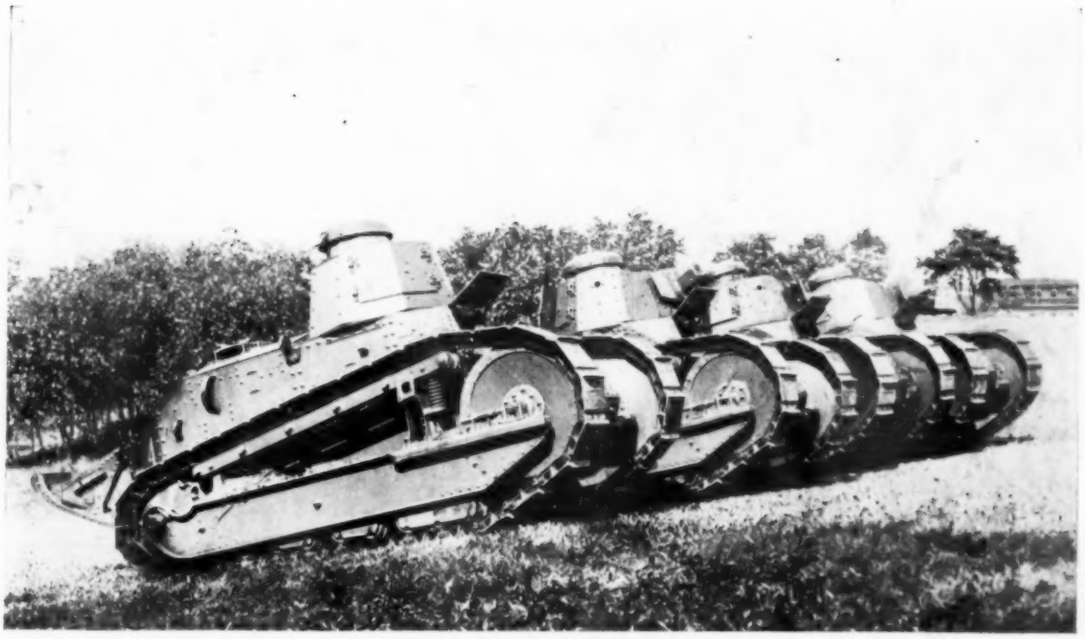


AMERICAN TANKS ON THE MARCH.

NINTH ANNUAL MEETING OF THE ARMY ORDNANCE ASSOCIATION
ABERDEEN PROVING GROUND, MD., OCTOBER 6, 1927

AUTOMOTIVE ORDNANCE
Maj. A. B. Quinton, Jr., Ord. Dept., U. S. A.

THE LABORATORY AT WATERTOWN ARSENAL
Col. T. C. Dickson, Ord. Dept., U. S. A.

THE SOCIETY OF AUTOMOTIVE ENGINEERS

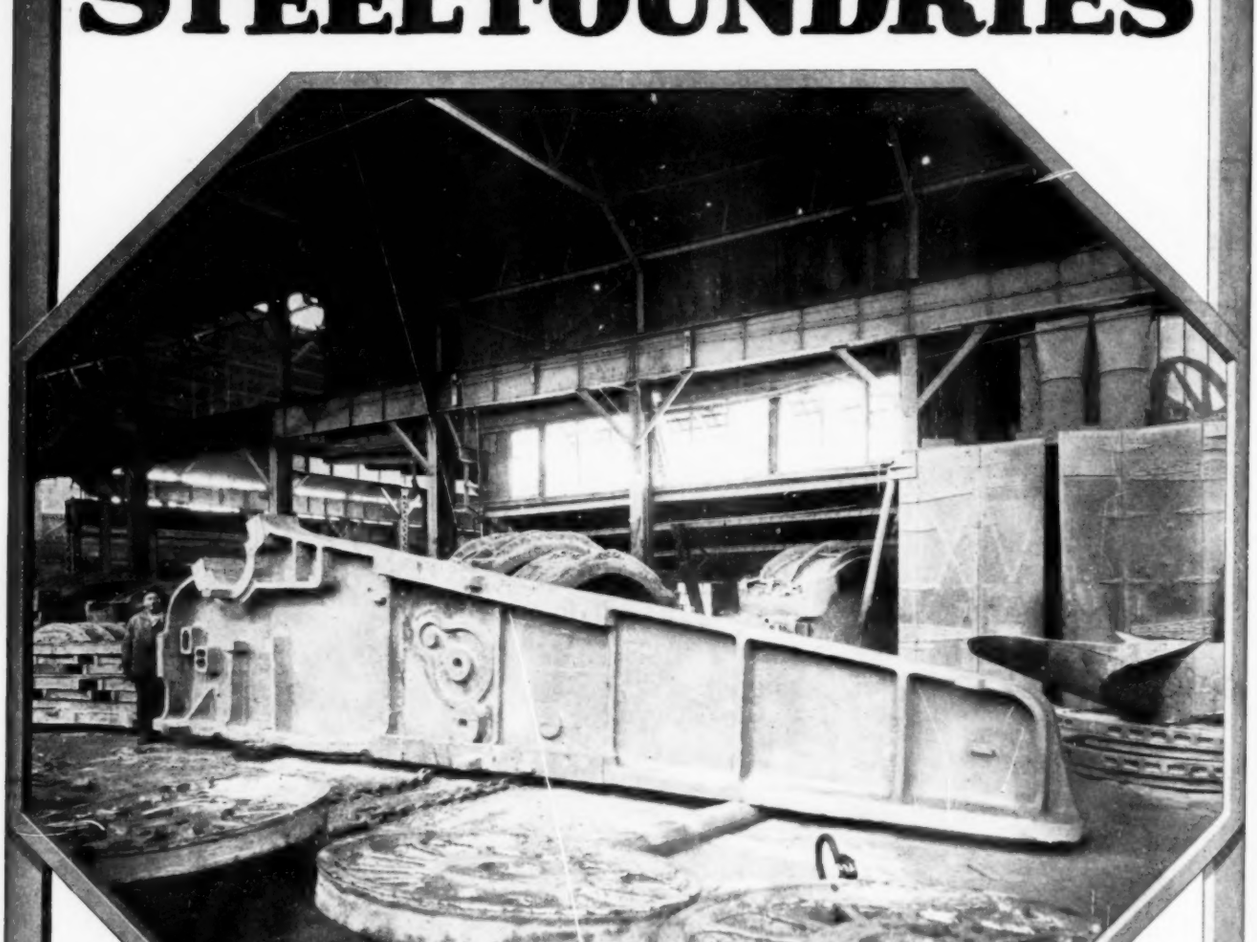
THE MILITARY ORDER OF THE WORLD WAR

THE AMERICAN SOCIETY FOR TESTING MATERIALS

AOA

THE JOURNAL OF THE ARMY ORDNANCE ASSOCIATION

AMERICAN STEEL FOUNDRIES



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ARMY ORDNANCE

THE JOURNAL OF THE ARMY ORDNANCE ASSOCIATION

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"The increasing interest all over the nation in industrial preparedness is a frank declaration to the world that we not only want peace but that we intend to have it."

HANFORD MACNIDER, *Assistant Secretary of War.*

THE NINTH ANNUAL ORDNANCE

WILL BE

ABERDEEN PROVING

OCTOBER

The Society of The Military Order the American Society for

Tentative Program

(Detailed program of events will be distributed at the Meeting.)

9:30 A. M.	Arrive Aberdeen Proving Ground.
10:00 A. M.	Seacoast Range—Opening Exercises.
10:20 A. M.	Demonstration of seacoast and antiaircraft artillery.
11:00 A. M.	Aviation Field—Aircraft, aircraft armament and bombs.
12:00 M.	Dinner.
1:00 P. M.	Main Front—Automotive demonstration.
3:00 P. M.	Main Front—Mobile artillery demonstration.
5:00 P. M.	Administration Building — Business meeting, Army Ordnance Association.
6:00 P. M.	Supper.
7:00 P. M.	Main Front—Antiaircraft demonstration and pyrotechnic display.

Reduced Railroad Fare

Members of the Army Ordnance Association, the Society of Automotive Engineers, the Military Order of the World War, and the American Society for Testing Materials, can travel to the meeting at reduced fare by presenting Identification Certificate to the local railroad ticket agent at practically any point in the United States. Certificates, with invitations and other data, have been sent to all members of the Army Ordnance Association and participating organizations. A round-trip ticket to Aberdeen, Maryland, purchased under this plan will cost one and one-half times the one-way fare.

Special Train

A special train of Pullman sleeping cars open for occupancy at 10 o'clock will leave Pennsylvania Station, New York City, shortly after midnight, October 5th, arriving at Aberdeen Proving Ground for breakfast. Returning, this special train will leave the Proving Ground after the night demonstrations and will arrive in New York in time to make midnight connections for other points. Maj. P. R. Faymonville, Secretary, New York Post, Army Ordnance Association, 39 Whitehall St., New York City, will make reservations for those who desire to travel on this train.

MEETING OF THE ARMY ASSOCIATION

HELD AT

GROUND, MARYLAND

6, 1927

Automotive Engineers of the World War and Testing Materials will Participate

Train Service

Trains as numbered will stop at Aberdeen on October 6, 1927. Consult latest time table for possible minor changes in time. Time shown is eastern standard.

GOING

Southbound— Leave	Pennsylvania	Baltimore and Ohio
Philadelphia:	Train No. 405	Train No. 15
Broad Street	7:20 A. M.	———
West Philadelphia	7:25 A. M.	———
Wayne Junction	———	7:45 A. M.
24th and Chestnut	———	8:02 A. M.
Arrive Aberdeen	8:56 A. M.	9:26 A. M.
Northbound—	**Train No. 110**	**Train No. 4**
Leave Washington	7:25 A. M.	7:30 A. M.
Leave Baltimore		
Union Station	8:23 A. M.	———
Camden Station	———	8:21 A. M.
Mt. Royal Station	———	8:27 A. M.
Arrive Aberdeen	8:57 A. M.	9:06 A. M.

RETURNING

Northbound—	Train No. 134	Train No. 28
Leave Aberdeen	8:29 P. M.	9:00 P. M.
Arrive Philadelphia:		
West Philadelphia	9:55 P. M.	———
Broad Street	10:00 P. M.	———
24th and Chestnut	———	10:40 P. M.
Arrive New York	12:25 P. M.	———
Southbound—	**Train No. 129**	**Train No. 9**
Leave Aberdeen	8:40 P. M.	8:10 P. M.
Arrive Baltimore:		
Mt. Royal Station	———	8:56 P. M.
Camden Station	———	9:01 P. M.
Union Station	9:25 P. M.	———
Arrive Washington	10:25 P. M.	9:50 P. M.

Meals Reservation

Commanding Officer, Aberdeen Proving Ground, Md.

I will attend the Ninth Annual Meeting of the Army Ordnance Association, October 6, 1927. Please reserve

Dinner (Noon) $1.00

Supper (6 P. M.) 1.00

for me on that date. My check for ..... drawn to your order is enclosed.

Send meal tickets to: .....

(Name)

(Street Address) ..... (City and State) .....

(Make check payable to Commanding Officer, Aberdeen Proving Ground)

Note—Please mail this request without delay. Your reservation must reach the Proving Ground not later than October 3rd. It will not be practicable to refund for meal tickets ordered.

All meals—Army food in Army style—will be served by the Quartermaster Corps, U. S. A.

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THE Army Ordnance Association is a national organization of American citizens pledged to industrial preparedness for war as our nation's strongest guarantee of peace.

THE Association endeavors to keep alive an interest in and knowledge of the design, production and maintenance of munitions. Other than a few manufacturing arsenals—six in all—there is no peace-time industry for the production of ordnance. Should war unhappily come again, industrial America will be called upon to produce munitions in great quantity and of intricate and unusual design. In an emergency time will not permit careful study or long preparation for the production of munitions. The problem is one of vital concern.

THE Army Ordnance Association believes that the solution of this problem, based on experience, lies in an active organization at all times cooperating with the Government. The principal objective of the Association is an active membership of American citizens, on whom the duty of design and production of munitions will fall in war, who will have an accurate and authentic knowledge of the complex requirements of ordnance. "Peace Insurance" in this form is the foremost aim of the Army Ordnance Association.

THE Association is purely patriotic; it has no commercial interests, no political alliances, and no religious affiliations. It is not operated for profit: its income is expended in furthering its aims. Its officers and directors serve without remuneration.

ARMY ORDNANCE, the journal of the Association, is published solely for the purpose of disseminating information on the progress of our munitions developments so that American industry may at all times know its responsibilities to the common defense.

The objectives of the Association as set forth in its Constitution are:

To assist in effecting industrial preparedness for war as being one of the nation's strongest guarantees of peace;

To keep available the highly specialized knowledge necessary for arming the manhood of the nation by stimulating interest in the design and production of ordnance material;

To promote mutual understanding and to effect cooperation with American Scientists, Inventors, Engineers and Manufacturers in civil life and the Regular and Reserve Officers of the Army Ordnance Department;

To provide, when required, the services of competent committees to investigate and report upon special ordnance subjects;

To assist in developing and maintaining an efficient personnel, both commissioned and enlisted, for the units required for Ordnance Field Service in the event of an emergency;

To commemorate the services rendered by the Industry of the Nation and by the Officers and Civilian Employees of the Ordnance Department in the wars in which the United States has been engaged.

Communications should be addressed to
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Brig. Gen. Samuel Hof, Ord. Dept., U. S. A.

Assistant to the Chief of Ordnance

Upon recommendation of the Secretary of War and approval by the President, Col. Samuel Hof, Ord. Dept., U. S. A., formerly Ordnance Officer of the Second Corps Area with station at Governor's Island, New York, was appointed, effective July 20, 1927, an Assistant to the Chief of Ordnance with the rank of Brigadier General, vice Brig. Gen. John W. Joyes. General Hof will be stationed in Washington, where he will serve as Chief of Ordnance Field Service.

A graduate of the United States Military Academy, Class of 1894, General Hof was born in Wisconsin, October 24, 1870. Graduating eighth in his class, he was commissioned a second lieutenant of Cavalry, served for a time at frontier posts, and four years later transferred to the Ordnance Department. Since then he has seen service at practically every arsenal in the United States.

The new Assistant to the Chief of Ordnance, holder of the Distinguished Service Medal and a graduate of the Army War College, won recognition during the World War by his capable administration of the Frankford Arsenal, Philadelphia, Pa. Later he became chairman of the Ordnance Claims Board, adjusting hundreds of munitions claims after the Armistice.

General Hof, one of the first Ordnance officers to graduate from the Harvard School of Business Administration, received his M. B. A. degree, with distinction, June, 1926.

ARMY ORDNANCE

VOL. VIII SEPTEMBER-OCTOBER, 1927 No. 44

Automotive Ordnance

Maj. A. B. Quinton, Jr., Ord. Dept., U. S. A.*

FROM time to time the public rides a military hobby exploiting some branch of the Service as the sure-shot panacea for defeat in all future battles, and, by inference, in wars too. Publicity of this kind may not be without its merit since it is likely to lend impetus to a betterment of the arm in question, but as to the contention that victories will be assured thereby, it is only necessary to point out a few of the many factors making up major warfare to show how trivial such contentions are.

We cannot get away from the axiom that polities begins, conducts, and ends wars. But what influences polities? Here are a few of the factors pertaining to the Army: man power both for the Army and of commercial industry, training of man power of each class, wealth, equipment of the Army and of commercial industry as to quantity and quality, supply in the Army of finished products and to the manufacturing plant of raw materials, transportation everywhere, military leadership, morale of troops and many other items.

A marked superiority in any one of these items might win an occasional battle, but not necesarily a war, while, on the other hand, a marked inferiority might spell defeat in both. Our best security is a demonstration of superiority in as many of the above mentioned factors as possible.

What the general character of the next war will be nobody knows. Perhaps it will be a stand-still affair, the kind used to wear out the opponent, or one replete with rapid movement, or more likely an intermediate form combining both trench and maneuver. No matter what the form, however, mobility of matériel and personnel will be a sure factor of power if not a necessary auxiliary to win.

While it is not claimed that motorization will win the next war, neither is the claim thought extravagant that extensive motorization in our Army is important —and inevitable.

Other countries are developing this idea very broadly, one in particular appropriating annually many times the amount of our current apportionment for this class of matériel. Considering the fact that the United States possesses over 80 per cent. of the world's automotive manufacturing facilities, we have a golden opportunity, literally speaking, to get the jump on the other fellow, and it is hoped that we will not pass up this chance of establishing a superiority of mobility in our Army.

It is the purpose of this article to indicate briefly the steps which the Ordnance Department of the Army has taken to meet the demand which has arisen for this specialized class of automotive equipment.

The logical classification of this matériel consists of: tractors, vehicles for cross-country transportation, tanks, motor gun carriages, and armored cars. These will be discussed in order.

Mark IX Motor Gun Carriage

Designed to mount either the 155-mm. gun or 8-inch howitzer. With gun removed it may be used as a tractor for heavy artillery.

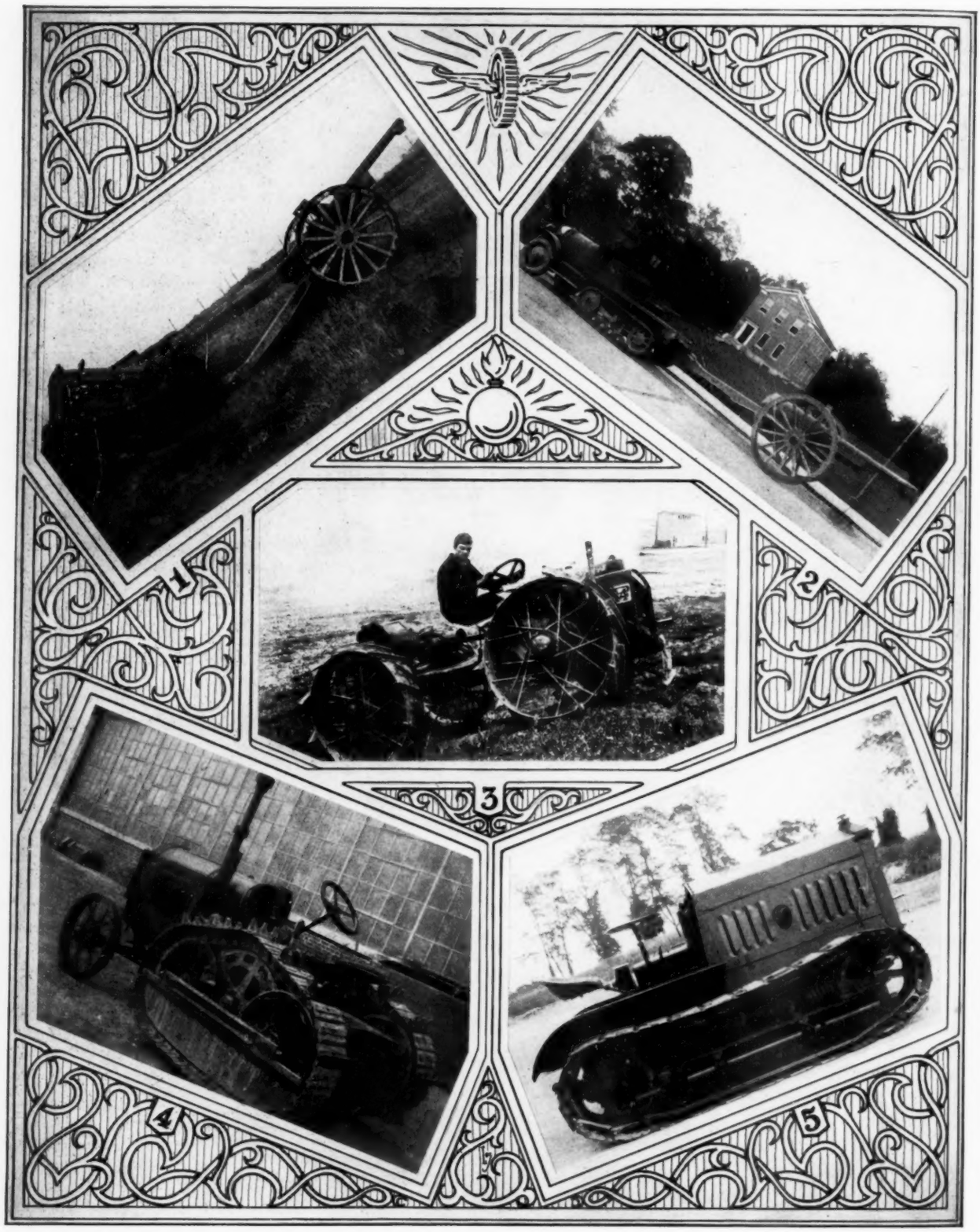
Tractors

Light Tractor

With reference to the light tractor, our Army will not start in the next emergency with the material on hand to be supplemented later with a war production product of standard or new type. The fact is that we do not possess any quantity of divisional tractors worth mentioning. Our entire war reserve stock of tractors on hand is composed of the old 5- and 10-ton Holts of war-time fame, which are intended and suited primarily for use with corps and army matériel.

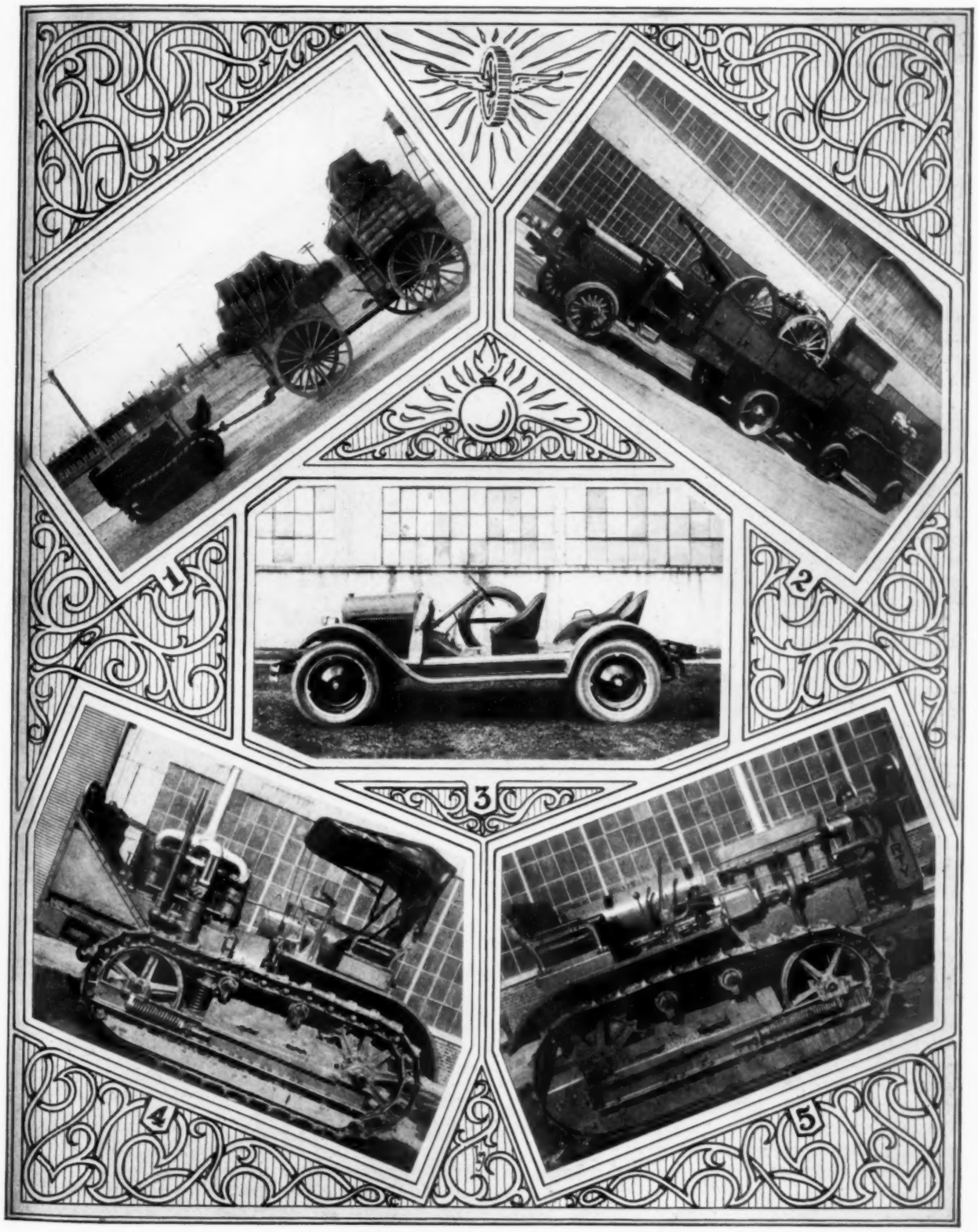
No divisional tractor was produced during the war as artillery motorization had not progressed to that stage, nor has any decision been made to this time as to the extent of the motorization of such units in the future.

*In charge of the Design Department, Aberdeen Proving Ground, Md.



Ordnance Automotive Equipment

1. The popular Fordson converted to a tracklayer by addition of full-crawler mechanism. 2. The French Citroen car with Kegress-Hinstin adapter—tested at Aberdeen Proving Ground as an all-purpose combination for reconnaissance, cargo-carrying, and as a prime mover. 3. The Pavesi artillery tractor, tested at Aberdeen Proving Ground and Fort Bragg. 4. The McCormick-Deering 10-20 tractor with Hadfield-Penfield adapter has been tested in comparison with the Fordson similarly equipped. 5. The Cletrac "30"—dynamometer tests show this commercial tractor to great advantage for military use.



Ordnance Automotive Equipment

1. The standard light tractor of the Army, the Caterpillar 2-ton, towing experimental cargo carts, T2. 2. For rapid transport of light artillery matériel on good roads this scheme has much merit. The prime mover, a class B truck, carries the gun and caisson and draws a 3-inch field gun and trailer with its 5-ton artillery tractor load. 3. The Chevrolet cross-country car (experimental). 4. The Caterpillar "60"—a commercial product selected as standard for army artillery matériel. 5. The Caterpillar "30"—an artillery tractor adopted as the standard medium tractor for American field artillery.

Not having any so-called ideal divisional tractor on hand and knowing the impracticability or impossibility of obtaining anything like an adequate supply of such in a short time, the Chief of Ordnance decided some four or five years ago upon the very wise policy of placing dependence upon the commercial tractor industry for supplying our needs in any future emergency. It matters not then to what degree we may become involved in any motorization scheme, we are not in such a precarious position as would be indicated by the present shortage of suitable tractors, because there exist adequate facilities for the manufacture of commercial tractors in quantities sufficient, probably, for our needs.

Before going into any details of Ordnance tractor development and investigation, it will not be out of place to reflect briefly upon the following factors which must be considered in determining upon the suitability of a tractor for any particular use: (a) reliability, (b) required speed, (c) cruising radius, (d) weight, (e) ratio of drawbar pull to weight, (f) provision for lighting, (g) armor, (h) height of drawbar, (i) seating capacity and arrangement, (j) accessibility of main assemblies, etc.

All of these are design characteristic problems which are practicable of solution to the ultimate satisfaction of the most exacting service by utilizing a special design, but which to date are only partially provided in any one of the commercial tractors yet tested. It is to be remembered too, that opinion upon these various characteristics is not a fixed one but varies continually. Today, the Ordnance Department may be asked to supply a tractor with armor and to travel at a maximum speed of 12 miles per hour—tomorrow one without armor and with a maximum speed of but 6 miles per hour. It is not inferred that such changing opinion is of a vacillating character but rather one indicating progress in thought.

It is evident, of course, that it would be simpler to keep abreast of such reasonable changing demands in a tractor of special design than in the commercial product over which the War Department has no control, although our contact with one of the largest tractor manufacturers has been and will continue to be helpful in keeping him informed of our needs resulting in a modification of his vehicle if his profit is not affected adversely thereby.

The word "profit" is used advisedly because it is upon this that the answer hinges to the inquiry of whether we may not expect greater improvement in the commercial tractor to meet our special requirements. It is argued that the commercial tractor application to road building, logging, snow removal, farming, etc., closely approximates the duty of pulling guns, transporting ammunition, etc., all of which is true, yet there is one fundamental difference between the two which separates them beyond much hope of ever bringing them together. The commercial tractor is built primarily for profit with performance, and reliability of secondary importance, while on the other hand, the tractor of special design is built primarily for performance and reliability, with the cost an item of much less importance.

On account of these basic differences it has been impossible as yet to discover any commercial tractor meeting 100 per cent. our more exacting demands and for the same reason the outlook, in the near future, is not hopeful of finding any such commercial vehicle.

It will not suffice to accept the commercial vehicle with the reservation of making major changes therein to adapt it to Army needs, because such a course might develop difficulties as numerous as though production of the special design were inaugurated.

The initial step taken by the Ordnance Department during the World War in the selection of a light tractor was the development of the so-called special vehicle, first the Model 1918 followed by the 1920 Model. No attempt will be made to give a detailed description of these tractors or of those which will be mentioned later as it will suffice to call attention to the outstanding characteristics only.

The 1920 tractor exemplifies to a marked degree the combination of performance, weight, speed and accessibility expected in the special vehicle. Data covering its reliability are recorded in the thorough tests made at the Aberdeen Proving Ground and at Fort Bragg. Although nothing further has been done with this tractor since its test by the Field Artillery it will serve as an excellent model around which to build a new pilot in case the project is revived.

When the Ordnance Department turned to the commercial field for its answer to the light tractor problem attention centered first upon the well-known Fordson because, like the Ford car, of its reputation for dependability and large production.

The Fordson is a wheeled vehicle and in order to insure better cross-country mobility there have been procured and tested upon it practically all commercial track attachments obtainable, including: Bates adapter, Hadfield-Penfield adapter, full crawler, Johnston track pull. While all of these attachments improve the performance of the Fordson they, without exception, impose upon the tractor an additional load which it was not designed to take, with the consequent result of excessive engine wear and general decreased dependability.

Service tests, however, indicate that in an emergency the Fordson with suitable adapter can be used to advantage and it so appears upon the Book of Standards as a substitute for manufacture.

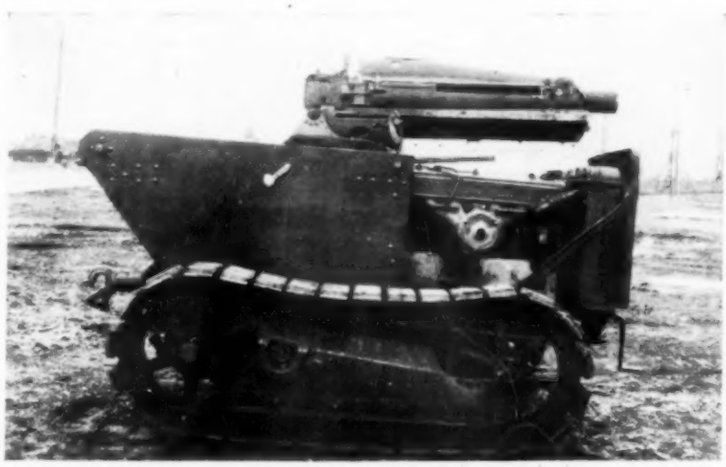
A word might be said of the production of this combination vehicle: there are large production facilities for the tractor proper with extremely limited production of the track attachment so that if its adoption is predicated upon the necessity of using a track attachment ample provision should be made in the war plans for the adequate production of this item.

Following the Fordson tests many other promising commercial tractors were procured and tested. Included in the list are the Caterpillar 2-ton, Mead-Morrison, Citroen, Holt T-30, Topp-Stewart, Pavesi, Best "30," and McCormick-Deering 10-20. Of these the Caterpillar 2-ton has received, and justly too, the most attention because of its excellent performance, its construction along conventional lines and by the largest tractor manufacturing concern in the country, excepting Fordson. It is quite dependable, but its main shortcoming is in its low drawbar pull capacity. Two batteries have been fully equipped with these vehicles, giving satisfaction sufficient to warrant its adoption as a standard for manufacture.

Citing this case of an exceptionally good commercial light tractor in no way contradicts the former statement made concerning the general suitability of commercial

vehicles. This one, the Caterpillar 2-ton, is not ideal, in fact it falls far short of it in capacity as mentioned. Its use in service tests by the Field Artillery furthered the argument started when the Fordson was introduced, this argument being apropos of the necessity of splitting up the time honored light artillery load of limber and gun or caisson due to the inability of these light types to pull the double load. The ability of the Caterpillar 2-ton in this respect is debated but from observation of tests at the Aberdeen Proving Ground it is believed that a 5,000-lb. load is too much to expect the tractor to handle under normal field conditions. If the load is not to be divided the Artillery will have to resort to the unwieldly expedient of double heading to negotiate severe going and if the load is divided a situation wasteful in personnel, tractor matériel and road space results.

To show the necessity of keeping Proving Ground tests abreast of the commercial production of changing models there can be cited the case now in point, namely, the Caterpillar 2-ton. It has just been stated that this tractor has been adopted as the standard of manufacture when word now comes from the manufacturer of the intention to discontinue its production in the very near future. It is his plan to make in its place another tractor of similar characteristics, and according to rumor it will be heavier and consequently better adapted to light artillery use than the present model perhaps to the extent of handling the double load satisfactorily. When the new tractor is marketed the Ordnance Department will have to procure one or more for test to determine its worthiness of adoption.



An experimental conversion of the Caterpillar 2-ton tractor to a motor gun carriage, the pack howitzer, Model 1923, mounted.

In addition to the Fordson and Caterpillar 2-ton there is another type, the McCormick-Deering 10-20, creating considerable interest as the result of Proving Ground tests. This one is produced in large quantities, performs at least as well as the Fordson, and consequently might well be considered in the same class as the latter for substitute manufacture. The proof of this feeling toward the McCormick-Deering will be found shortly in the tests to be made at Fort Bragg.

While several of the other tractors of this class gave good accounts of themselves in test, justifying continued attention in their future production, no further mention need be made of them at this time.

Medium Tractor

The procedure followed by the Department in the selection of a medium tractor has been quite similar to that described for the light machine. The most promising types in the commercial field have been procured and tested at the Proving Ground followed by service tests by the Artillery, although the latter tests have been on a less extensive scale than in the case of the light tractor. Again there has been selected a product of the Caterpillar Tractor Company, namely, the Caterpillar "30," formerly the Best "30," as the standard for manufacture for the draft of corps artillery, thereby displacing the old war-time Holt 5-ton tractor which moves down the scale to the position of a substitute.

A special medium tractor designated "Corps Tractor Model 1921," designed and built by the Ordnance Department, has been under test recently at Fort Bragg by the Field Artillery. The Proving Ground tests indicate a performance in the handling of the corps artillery matériel superior to that of the Caterpillar "30" which is the standard selected. The reaction of the Field Artillery Board to the thought of continuing development of this class of special tractor is best shown in the following quotation from the Board's Report: "In view of the performance of the tractor the effort is worth while, for while the commercial models will answer our purposes at present there is no guarantee that this will be so indefinitely. If the Ordnance is ever called upon to build our tractors in the future, as with the guns, it can only be done successfully with the background obtained from the gradual refinement and improvement of pilot models built to meet military specifications."

Heavy Tractor

The heavy tractor problem can not be solved by commercial tractors to the same degree of satisfaction as has been done in the case of the light and medium types. In the first place there is not a single commercial tractor on the market approximating the requirements laid down for the heavy type vehicle. The main quality lacking is that of capacity. Commercial tractors of 10-ton weight are the largest produced and it is not reasonable to expect one of that weight to handle a 15-ton artillery load under the most severe conditions. The logical solution has been resorted to, namely, the adoption of a commercial tractor best suited to this duty with a complete realization of its limitations. Such limitations impose the use, not as an expedient in this case, but a normal condition, of double heading to negotiate bad ground or grades. The heavy tractor which has been selected as standard is another Caterpillar product, the "60."

Mention will be made later of the test of the Mark IX motor gun carriage as a tractor for heavy artillery representing a good start toward the development of a special type.

Cross-Country Transportation

One of the most difficult development projects in this

general motorization scheme has been the provision of facilities for cross-country transportation of cargoes and personnel, and in this development the Ordnance Department has been on the alert every minute, missing no chance to try out every device offering any chance of fulfilling the diversified requirements presented. In fact, if any criticism were offered it might incline more justly to the side of too active interest in devices which now, upon retrospection, appear to have been without full hope of success. A careful review of the projects, however, will show a continuity of thought throughout this research responsible in a large measure for the success which has been attained in certain branches of the problem.

Considering first the cargo transportation side of the subject, it is at the rail head where the Army's trouble starts. In many instances, for a definite distance beyond the rail head, the conventional motor truck can be used to great advantage, in addition to its use in augmenting the supply by rail along parallel routes up to the rail head.

When the motor truck stops, and it will stop too, dependence will have to be placed upon the more specialized modes of travel supplied by the Ordnance Department. Forgetting for the moment the carrying of supplies and equipment in the immediate vicinity of the most advanced firing point, three systems of cross-country transportation of general supplies are open. These, listed in order of increasing promise and application, are: the modified motor truck, the tractor caisson and the tractor-trailer combination.

The modified motor truck has been tested very thoroughly, and in certain forms it is still under development or test. The modifications consist either in adding a track attachment or converting to a 6-wheeled vehicle with the 4 rear wheels driven. As to the former method there can be cited the work with the 3- to 5-ton commercial trucks equipped with the Christie, Gilliland, and Roadless adapters; the application of fabric, rubber and steel cable variety tracks to commercial or standard truck chassis, such as the Ford, Dodge, Militor, and Citroen. In fact, the ideas on this matter are pretty well played out and at the present time, the Ordnance Department has nothing of the kind under test, nor, it is believed, any new project under consideration.

In discontinuing this line of development, at least for the present, the conclusion is reached that the truck with track attachment fulfils no useful need in the cross-country transportation scheme because the margin of difference between the improved performance of the tracked-trucks and that of the plain conventional truck is not great enough to compensate for the complexity of construction, supply, and maintenance of this specialized vehicle.

A more promising type of the modified truck idea is shown in its conversion to a 6-wheeled machine.

A truck so constructed with large balloon tires all around, and 4-rear-wheel driven, has demonstrated a performance much better than that of the conventional truck in all tests made at the Proving Ground. One vehicle of this kind, a converted Dodge, is now under test by the Infantry Board primarily for the purpose of examining into the tactical need of such means of transportation, the original thought being that it might serve as a mechanical transport replacement for the horse-drawn limbered combat wagon and for general cargo purposes. The whole scheme looks promising, so much so in fact, that additional projects are now under way to convert other types of commercial truck chassis along similar lines.

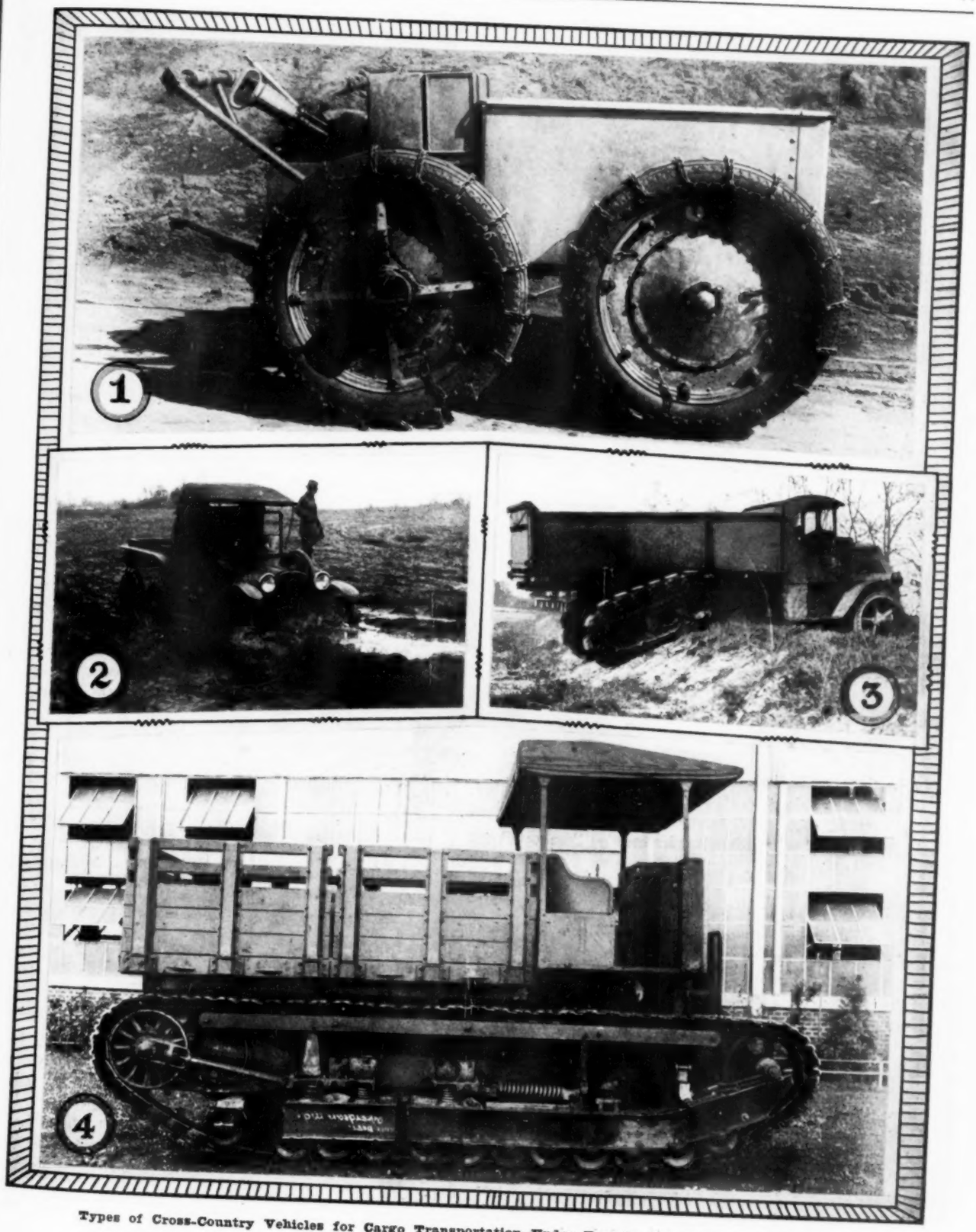
It is also interesting to note the line of development being followed by foreign nations, and, in addition, it is gratifying to learn of conclusions reached abroad which are the same as our own. This comment applies directly to the knowledge that England has given official recognition to the utility of the 6-wheeled, 4-wheel-driven trucks for cross-country cargo transportation as evidenced by the fact that a subsidy of 40 pounds per annum for three years is guaranteed to the owners of trucks of this general class built to conform to the War Department specifications. Incidentally, the specifications as published appear to be so rigid that the British War Department will be assured of a potential war reserve of cargo vehicles suited in all respects to its war needs.

Whereas it has been said that there will probably be a place in the picture for a converted truck of this general type, there must be a limitation to its use at some stage as yet undetermined, necessitating the employment of still another form of transportation more efficient in its cross-country performance. This at once implies the track-layer, and, as itemized in the beginning, the two remaining possibilities consist of the tractor caisson and the tractor with trailer.

The choice between these two was the basic subject assigned for study to a special subcommittee of the Ordnance Committee in 1923. The conclusion reached and recommendations approved specified the selection of the tractor-trailer for the cross-country transportation of all army cargoes, with the exception of supply to tank units, for which service the tractor caisson seemed better suited.

The logic of the conclusion drawn is at once apparent, based as it is upon the utilization of the same type of equipment available for other purposes, that is, the tractor used for cargo draft is to be the same as that presumably existing for the draft of artillery matériel, leaving then only the matter of supplying a trailer to complete the equipment.

In the development of the trailer idea, the Ordnance Department has designed, built and contracted for several trailers of the track-laying variety, and, in addition, procured outright some of the commercial wheeled types for test. Dynamometer tests have been made with the various models, track-laying and wheeled, to determine the relative resistance to traction over courses of different degrees of resistance. These tests show up the tracklayer to disadvantage on good ground, with much in its favor, however, in traveling on soft ground where the better floatation of the track machine comes into its own. The track item, however, does not begin to be as important in the trailer as in the prime mover where traction is the prime consideration, and since the wheel is so much more durable than any track device stress has been placed on the wheeled type trailer. That this is reasonable, too, it will be agreed when it is recalled that the normal trail load for the tractor to be used in the transport of cargoes is a wheeled vehicle, namely, the gun carriage. Why not then, load the cargo on a vehicle of the same total weight, with the same type and size of wheel as the gun carriage and expect the same



Types of Cross-Country Vehicles for Cargo Transportation Under Test by the Ordnance Department

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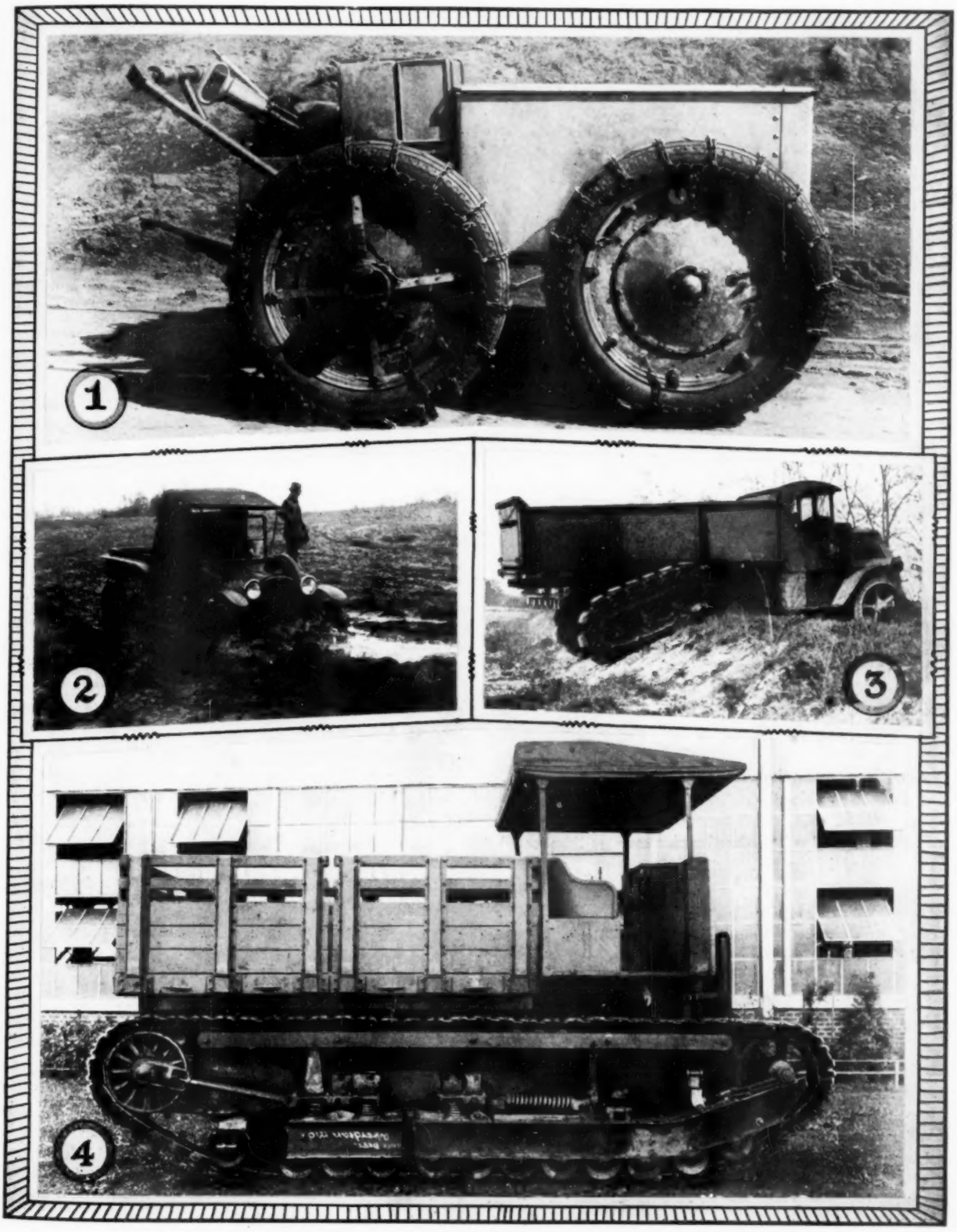

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cross-country mobility that the mobile artillery will have? This has been tried and works well, giving a reasonably satisfactory solution.

The first trial along this line consisted in the utilization of a 75-mm. gun limber, the chest of which was replaced by a more spacious box to accommodate cargoes of varied bulkiness. Two of these, limbered together, have a degree of mobility equal to that of the double axle load of light artillery, and for still greater mobility the load may be split.

An endeavor to improve upon the performance of the limbered 75-mm. gun limber so modified, designated as the T1 Cart, brought about the construction of the T2 Carts

The Medium Tank, Model 1922, demonstrating its trench-crossing ability in proving ground tests.

similar to the former, except in the manner of hitching them together to make a wagon type combination. Tests at the Proving Ground indicate that preference will probably be given to the limbered type, the T1 Carts.

In furthering this plan, it appears feasible to construct larger carts of this general type for use with a medium artillery tractor for handling heavier cargoes than can be accommodated in the light carts.

It has been stated that the needs of the Tank Corps do not appear to be met by the tractor-trailer method, as the tactical employment of the tank demands that the tank supply vehicle follow over the same terrain as the tank, for which service the tractor-trailer would not be suitable; but the tractor caisson, constructed with a track of proper contour, can be made to give the same mobility as the tank.

As a preliminary step in this development, the Mark VII Tractor Caisson of war-time construction was modified at the Aberdeen Proving Ground in 1924, and tested at Camp Meade not with the idea that that particular vehicle would be a satisfactory piece of service equipment, but rather to demonstrate and prove the theory of this method of transportation. Since that time decision has been made to utilize the light tank chassis as a cargo carrier. Some difficulties are met in so adapting the tank chassis to this use, but they are not insurmountable, and the plan appears to be feasible. Certainly, a special tractor caisson should not be supplied unless absolutely necessary.

The one remaining cargo-carrying activity not yet touched upon is the mechanical handling of supplies and equipment in the most advanced areas. The thought behind this is to relieve the Infantrymen of the burden of man-handling the heavier infantry weapons with their ammuntion, signal equipment, etc. The necessity of furnishing a special means of transporting such supplies was taken cognizance of in the Caliber Board report. This extreme condition of transport has been thought best met by a small power vehicle, commonly called the power cart. Several of these special types have been built and tested, the earlier ones serving the purpose at least of devloping a tactical need for them as a type, thereby influencing the Infantry in requesting further development of the idea. The last thought of the Ordnance Department is represented in a balloon tired, 4-wheel driven, power cart, designed and built at Rock Island Arsenal and now under test by the Infantry at Fort Benning. The future of the power cart can be predicted only after receipt of the next test report from Fort Benning.

The Caliber Board report also pointed out the necessity of finding some means of transporting personnel of a motorized organization, who, in a horsed outfit, would be individually mounted. Considering the capability of the horse in cross-country travel, fording and swimming of streams, ability to pass through narrow defiles, etc., the problem of supplying a mechanical form of transport to replace the horse presented a difficult task at the outset.

An attempted solution consisted of the construction of several types of track-laying reconnaissance tractors, special in almost every detail, some of them constructed to float and equipped with water propellers to parallel the performance of the horse, but the great drawback in all of them can be attributed to the fact that they were unreliable, and inherently so, due to the attempt to make them accomplish too much for the weight limitation imposed. Happily, for all concerned, the early tests at the Proving Ground with a Ford car equipped with airplane tires, before the advent of the commercial balloon tire, gave such excellent results that it became unnecessary to continue the experiments with the special reconnaissance tractor.

All officers in the Service are familiar with the success of the Ford cross-country car trials resulting in its adoption as standard. In this connection, however, it is thought appropriate to comment upon the proposition of selecting as standard commercial chassis which are subject to major alterations almost annually by the manufacturer, reference—the present case of the standard Ford chassis which is now no longer in production. It has been demonstrated that at least one other light commercial chassis is applicable to conversion to a cross-country car, and it is probable that several other models are available also. Consequently, it is believed that in our standardization war-time procurement would be facilitated if an option among several types were allowed.

Tanks

Tank projects have consumed a large portion of the effort expended by the Ordnance Department in all of its automotive development. Our Army came out of the World War with two types of tanks, the 6-ton and the

large 40-ton Mark VIII. The latter is supposed to have been built for a special mission, and consequently is not fully adapted to the general mission laid down for the tank. This being the case, attention was turned to the construction of a tank intermediate in its characteristics between these two, and in 1919 specifications were drawn for a new pilot along lines such as to establish the identity of a class now known as the medium tank.

These specifications prescribed such characteristics as trench-crossing ability, a function of the length and center of gravity; speed; armor; armament, including number, caliber and arrangement of weapons; cruising radius; quantity of ammunition to be carried, etc.

To meet these specifications in their entirety, it was found necessary to build a fighting unit weighing approximately 22½ tons, which weight exceeded that desired by the Service.

Two of these medium tanks, Models 1921 and 1922, alike in most respects, were designed and constructed by the Ordnance Department and tested, first at the Aberdeen Proving Ground and then at Camp Meade, and later returned to the Proving Ground for the completion of their life test.

With the exception of being over weight, these tanks as a type were found to be satisfactory. In certain components, defects common to most pilot vehicles developed, none of which is considered insurmountable. In fact, the Ordnance Department could put the 1921 medium tank in production today with every assurance of its giving better mechanical service than is obtained from either of the two standard tanks now in service. It is not inferred in drawing this comparison in performance and reliability that the 1921 tank is a super-vehicle, but rather to stress the fact that the tanks with which our Service is now equipped are of obsolete design and have seen their best days. The 1921 tank represents a marked improvement, commensurate in a way with the general progress made in the design of heavy track-laying vehicles. It does not, however, represent the ultimate, and it is believed that the new medium tank, recently completed at Rock Island Arsenal, will mark still another step forward in this field of design.

The new medium tank is being placed under test this summer. In it the Ordnance Department has retained units proven successful in the earlier 1921 model, while other units, designed to improve the behavior of the corresponding units of the earlier tank, have been incorporated only after a thorough tryout in the old tank. With the limited funds now available, it is considered much wiser to pin faith in well proven component designs, as has been done in the new medium tank, than to try out many new ideas. Such procedure, too, will assure the most expeditious delivery to the service of a usable vehicle.

It might be added, however, that this "safety first" method is not calculated to contribute many revolutionary improvements to track-laying vehicle design and assuredly there is room for many small revolutions. To try out new ideas, which today seem radical, would require considerably more money than is available, hence the Ordnance Department is deterred from attempting short cuts to the design of 10 to 15 years hence.

Reference has been made to the fact that the first pilot medium tank was over weight. This caused grave concern in some directions, principally on account of having exceeded the capacity of the divisional pontoon bridge set at 15 tons. A thorough consideration of the matter brought out two lines of thought, one that the minimum requirements of a fighting tank of this class are as represented in the 1921 model, which is over weight, the other that the tank cannot operate independently of the pontoon bridge, hence, the bridge capacity must be held paramount.

Preliminary studies were made of a 15-ton tank, resulting, in every case, in a sacrifice of one or more of the minimum requirements. Eight or even five tons cannot be stripped off the 23-ton vehicle without paying the price in reduction of length, in thinning of armor, in mounting fewer or smaller guns, in carrying less ammunition, or without lessening the reliability of the tank as a whole.

The 1921 Medium Tank under test in one of the prepared testing areas at the Aberdeen Proving Ground.

However, further study along this line is contemplated. This study will be made concurrently with the test of the new 23-ton medium tank, and by the time the report of test of the latter is submitted, a recommendation will have been made as to whether or not a medium tank to weigh a maximum of 15 tons should be developed. If developed, this tank will not be for use in addition to the 23-ton unit, but will be *the* medium tank.

Thus it is seen how the matter stands today; we may or may not adhere to the 23-ton type, or the corollary, we may or may not develop a 15-ton tank.

Motor Gun Carriages

Motor gun carriage development, at present, is quite inactive as compared to the situation existing six or seven years ago. It will be recalled that at the time of the Armistice, projects covering the entire field of activity of this form of artillery transport were actively engaged upon. The branch of this work on which the Ordnance Department had centered most of its attention was the first to be curtailed; namely, that for light artillery. After tests of several of these types, it was found that no tactical need for them existed, consequently development ceased. The Field Artillery did, however, approve further development of the idea for medium and heavy artillery, but funds have not been adequate to push the work on either type.

If the views of the Field Artillery have been interpreted

correctly, the situation may be summed up in this way: any consideration given to the use of the motor gun carriage as a type is predicated upon the supposition that motorization in some form or other is contemplated. For light artillery, the horse appears to be favored at the present time, but if any unit is motorized, the tractor, rather than the motor gun carriage, is believed to be the first logical step. To substantiate this belief, its proponents can cite the disadvantage of putting the fate of the gun in the hands of the supposedly vulnerable power unit of the self-contained vehicle, arguing further that the advantage of increased mobility and readiness of getting in and out of action with the light motor gun carriage will be slight advantages at best. The immediate future, then, of the motor gun carriage in the general mission of light artillery is not bright.

As a special mission problem, however, there is some chance of finding a tactical need of a light gun so mounted. The tank is a new weapon, relatively. Its use in the last war was a one-sided proposition, and defense against it was not developed fully. Tank against tank may be the best solution, but can there not be visualized as a defense, a 75-mm. gun, greater in caliber and power than that likely to be found in the enemy tank, mounted on a small motor vehicle of such mobility that it can be concentrated readily at a point further advanced than the normal artillery position to aid in the repulse of a tank attack.

The Ordnance Department is investigating the feasibility of this plan, the initial step being evidenced in the mounting of the pack howitzer, Model 1923, on the commercial T-35 tractor undertaken recently at the Aberdeen Proving Ground. In this mounting, no modification was made in the pack howitzer, and but minor ones would be required in the tractor in the final layout. It will be noted in this connection that this is the first instance in which the motor gun carriage unit has not been of special construction throughout. Commercial tractors do not lend themselves to such adaptation as a general thing.

Coming to the medium and heavy artillery, the motor gun carriage problem differs from that described for the light class. With the greatly increased weight of matériel, some form of mechanical transport is desired. Whether it will be the tractor combination or the motor gun carriage cannot be stated definitely, but if the present active projects are any criterion by which to judge the trend of thought, the tractor leads. As stated in the discussion of tractors, a tractor standard has been approved for both the medium and heavy artillery, but as yet no motor gun carriage of any description is shown in our Books of Standards.

It might be mentioned that one inherent and very attractive advantage attributed to the motor gun carriage for heavy artillery is the ease with which the gun can be put into action.

A good opportunity to compare the relative advantages of the tractor and motor gun carriage in artillery draft was afforded the Service recently in the test of two Mark IX motor gun carriages at Aberdeen Proving Ground and at Fort Bragg. These mounts, designed especially to take the 155-mm. gun or 8-inch howitzer, are alike in their main characteristics. When sent to Fort Bragg, one of the Mark IX's with gun removed and drawing a 155-mm. G. P. F., was tested against the other with an 8-inch howitzer mounted thereon. In this test an Ordnance observer reported that the Mark IX motor gun carriage with howitzer mounted thereon handled its load satisfactorily on slopes, which it had been found impossible for the six-horse team to negotiate with the light artillery load.

For the medium artillery a motor gun carriage, Mark X, was developed and tested in 1925. Test showed the necessity of modifying the track assembly to better the weight distribution to prevent excessive wear in certain track parts. Work on this project ceased at that point.

The value to the Service of testing this gun mount, after modification, has to be considered in the light of the relative interest in this and other projects, all struggling for a place in the Ordnance budget.

The information gained from the Mark IX, both as a motor gun carriage and tractor, may prompt a renewal of interest in the completion of the Mark X project, because the latter is probably just as well adapted for use either as a motor gun carriage or tractor for medium artillery.

Armored Cars

The one remaining class of automotive equipment to be touched upon is the armored car.

Serious consideration was not given this type during the war, primarily on account of the absence of any opportunity to use it advantageously. However, the subject was not ignored, as several commercial chassis were modified experimentally to take an armored body mounting a machine gun. Between 1918 and 1926 the matter lay dormant so far as the Ordnance Department was concerned, but was revived early last year upon request of the Cavalry. The development of an armored car for use as a Cavalry reconnaissance auxiliary will be undertaken in the near future.

After reading this recital of accomplishments, or lack thereof, it may be thought that better progress should have been made to date in view of the energy expended. In extenuation the old adage may be repeated, that in a new game of this kind many erasures are necessary before a permanent entry can be expected. When one reads in ARMY ORDNANCE of continued experiments in the twist of rifling in cannon, twisted these many years, and of the test of three new types of cleaning rods for the Infantry rifle, less hesitancy need be felt in recommending continuation of any specific transmission or engine test.

Raising of the issue of the horse and motor as competitors in transport has been purposely avoided because of the danger of lending credence to the idle talk sometimes heard of the reluctance of some in the Service to sacrifice to the slaughter the horse around which the traditions of certain organizations have been built.

It is true that in a change of this kind from horse to motor, as when the Navy changed from sails to steam, a few pessimists will arise to pour cold water on the idea, but in the final analysis any change made will be based solely upon merit, and, without any let-down in the high standard of morale and *esprit de corps* for which our Service is noted, even if the life of the pessimist remains perpetually clouded by remembrance of the presence of the noble steed 'neath the stable roof.

The Society of Automotive Engineers*

Its Activities for Standardization and Research in the American Automotive Industry

RAPID progress in the development of the motor vehicle during the last twenty years, the low prices of cars and the enormous number in use are due in great measure to the cooperation of engineers and their interchange of knowledge and ideas through the Society of Automotive Engineers. A saving of at least 15 per cent. in the total annual retail value of American automotive products is reliably estimated to have been effected by the standardization work that has been done by the Society, and the amount of convenience, time-saving and safety that the users of motor vehicles have enjoyed as a result of this work never can be estimated. The effects are evident in the manufacturing, servicing and use of cars and trucks especially. To form only the slightest idea of the value of this work, it is necessary only to imagine conditions if spark plugs were not standardized as to diameter and thread and there were perhaps fifty or more different sizes in the market.

C. H. Hunt, President, Society of Automotive Engineers.

Organized 1906

Organized in 1906, the Society of Automobile Engineers took over the work of automobile standardization which had been inaugurated by the National Association of Automobile Manufacturers in 1900 and continued and expanded by the Association of Licensed Automobile Manufacturers. In 1916 the American Society of Aeronautic Engineers and the Society of Tractor Engineers were merged with the Society of Automobile Engineers and the last-named organization changed its name from "Automobile" to "Automotive" and became active in standardization in aeronautic and tractor engineering. Subsequently, the National Association of Engine and Boat Manufacturers and the National Gas Engine Association took action whereby the Society of Automotive Engineers also became active in standardization in the motor boat and internal combustion engineering fields.

More than 600 standards and recommended practices have been approved by the Society of Automotive Engineers up to the present time. These are classified under the general heads of materials, nomenclature and tests, frame and spring, powerplant, transmission axle and wheel, tire and rim, control, body, electrical equipment, parts and fittings, and general.

Standardization work is now in progress on more than 60 subjects relating to passenger car bodies, motor trucks, motor boats, agricultural power equipment, engines, ball and roller bearings, electrical equipment, lighting, iron and steel, lubricants, parts and fittings, springs, and screw threads. The Society has twenty-eight standardization divisions and cooperates with twenty-seven other national organizations and six Government departments through the American Engineering Standards Committee.

From a membership of 400 at the end of 1909, the Society has grown to a present membership of 6,140, including nearly 100 foreign members located in all civilized industrial countries. Local sections of Society members have been formed in New York City, New England, Pennsylvania, Washington, D. C., Buffalo, Cleveland, Dayton, O., Detroit, Indiana, Chicago, Milwaukee, and Minneapolis, and northern and southern California. These sections and groups hold monthly meetings in addition to eight or more national meetings of the Society held yearly. More than 100 national and sectional meetings were held last year, at which nearly 200 addresses were presented on engineering, production, fleet operation, maintenance and other subjects.

Born 22 years ago as an organization with two officers and one other member, the Society has grown to its present membership in a very remarkable way.

It was informally organized in New York City in January, 1904, during the New York Automobile Show as a purely automobile engineering society under the name Society of Automobile Engineers. Present at the meeting were H. M. Swetland, publisher of *The Automobile*, now known as *Automotive Industries;* A. H. Whiting and E. T. Birdsall, an automobile engineer. This meeting was the outgrowth of ideas conceived by Mr. Swetland, who died several years ago, and which he had discussed with a number of leading engineers in the new industry. Andrew L. Riker, engineer of the Locomobile Company of America, was named as president and Mr. Birdsall as secretary and

*By invitation of the officers and directors of the Army Ordnance Association, the Society of Automotive Engineers will participate in the Ninth Annual Meeting of the Association at Aberdeen Proving Ground, October 6, 1927.

H. W. Alden.

W. G. Wall,
Vice-Pres. S. A. E.,
Chairman.

A. F. Masury.

Members of the Ordnance Advisory Committee

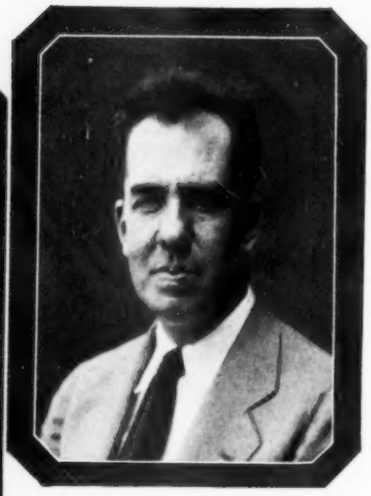
Society of Automotive Engineers

Pliny E. Holt.

C. M. Manly.

Dent Parrett.

E. B. Bachman.



A. W. S. Herrington.

treasurer. The three men constituted themselves a committee to draft a constitution, and at a second meeting the following January Mr. Riker was elected president for 1905, Henry Ford, vice-president; John Wilkinson, engineer of the Franklin Manufacturing Co., second vice-president; Mr. Birdsall secretary-treasurer, and A. H. Whiting, L. T. Gibbs, H. M. Swetland, Hiram P. Maxim, H. W. Alden and H. Vanderbeek, managers. Memberships were solicited during the ensuing year and approximately 100 names were added to the list.

The first formal meeting of members was held in January, 1906, in New York and consisted of a dinner and a business and technical session at which the officers and managers were reelected and a program of engineering papers was presented.

Development was painfully slow during the succeeding four years because of lack of headquarters and a secretary who could devote all of his time to administering to the infant by day and sitting up nights to attend to its growing pains. Although interest in the Society was stimulated by a joint meeting with the Society of Mechanical Engineers in Detroit in 1907, the removal of Mr. Birdsall, the secretary, to Detroit and the lack of headquarters and constant attention created a disorganized condition.

Under Henry Hess, the third president, and Alexander Churchward, secretary, two important meetings were held in 1908. Following the election of Howard E. Coffin to the presidency in 1910, Coker F. Clarkson, who had been in charge of the mechanical branch of the Association of Licensed Automobile Manufacturers for a number of years, was appointed secretary and general manager to devote all of his time and efforts to the work. The scattered records of the Society were collected and the bank account, amounting to $250, was turned over to him. When some doubt of the ability of the organization to pay expenses was communicated to Mr. Coffin, he forwarded his personal check of $2,500 to be placed to the personal account of Mr. Clarkson, with instructions to draw on the account for the needs of the Society and the promise that when the amount was exhausted he would send whatever more was necessary. This is the Howard Coffin who instituted and organized the Council of National Defense in the early days of the World War. However, Messrs. Swetland, Riker and Hess desired to assist in financing the organization and each of the four men advanced $2,000, taking a promissory note for the amount. Of Mr. Coffin's original contribution, $500 was returned to him. An active campaign for members was then started and various committees were organized for standardization and other work to be undertaken.

Past presidents of the Society are as follows:

1905–7	Andrew L. Riker
1908	Thomas J. Fay
1909	Henry Hess*
1910	Howard E. Coffin
1911	Henry Souther*
1912	Henry F. Donaldson*
1912	Herbert W. Alden
1913	Howard Marmon
1914	Henry M. Leland
1915	William H. Van Dervoort*
1916	Russell Huff
1917	George W. Dunham
1918	C. F. Kettering
1919	Charles M. Manly
1920	Jesse G. Vincent
1921	David Beecroft
1922	B. B. Bachman
1923	Herbert W. Alden
1924	Henry M. Crane
1925	Harry L. Horning
1926	Thomas J. Litle, Jr.

*Deceased.

During all of its life the Society has devoted a large part of its attention to the standardization work that has distinguished the autmobile industry for its extraordinary cooperative spirit and which has been largely instrumental in furthering quantity production. This has made possible the almost continuous reduction of prices year after year coincident with the addition of more and more accessories to motor cars and the improvement of quality, increase of riding comfort and operating convenience, and reduction of operating and maintenance costs.

Approximately 600 automotive standards and recommended practices are now included in the S. A. E. Handbook, which is issued semi-annually as a bound volume of pocket size. An analysis of estimates made by more than 100 engineers and executives of leading companies in the automotive field indicates that the saving in dollars alone effected by the use of these standards amounts to 15 per cent. of the total retail value of automotive products.

The work of standardization is carried on with the utmost care and in cooperation with each industry and minor division of the industries that are affected by or interested in any subject that is under consideration for standardization. The Standards Committee of the Society has 25 divisions and numerous subdivisions with from three to twenty-four members each. Approximately 100 standardization projects are constantly in progress and of these about one-quarter are active each month, and from three to four division and subdivision meetings are held each month. The Society of Automotive Engineers is represented on research and standardization committees of a dozen other national bodies dealing with a wide variety of subjects, such as tests and specifications of steel, iron and non-ferrous metals; heat-treatment definitions; form and arrangement of specifications; Army and Navy aeronautic standards; aeronautic power plants; hardwood lumber standards; marine standards, and screw-threads.

Research work is also a main activity of the Society, which maintains a research department and is engaged in cooperative research with the Bureau of Standards, the Bureau of Public Roads, the National Automobile Chamber of Commerce, the American Petroleum Institute, and the Illuminating Engineering Society into the conservation of petroleum resources, vehicle impacts on roads, and motor vehicle headlight illumination.

The Society has performed a very praiseworthy service in the cause of national defense through its Ordnance Advisory Committee composed of Col. W. G. Wall, Chairman, and Col. H. W. Alden, Messrs. A. F. Masury, Pliny E. Holt, C. M. Manly, Dent Parrett, B. B. Bachman, A. W. S. Herrington, G. A. Round and W. L. Batt.

The Laboratory at Watertown Arsenal

1. Microphotographic equipment. 2. Centrifugal casting machine, maximum speed 1,500 r.p.m., for casting 75-mm. guns and 105-mm. howitzers. 3. 800,000-lb. Emery testing machine. 4. Physical testing room. 5. Chemical analysis room.

The Laboratory at Watertown Arsenal

Col. T. C. Dickson, Ord. Dept., U. S. A.*

THE laboratory at Watertown Arsenal appears to have been started by that distinguished and scientific Ordnance Officer, Maj. T. J. Rodman, Brevet Brigadier General, who designed and built apparatus for experiments and tests which he made while in command of the arsenal from 1859 to 1865.

The controversy over the relative merits of cast iron and steel for guns was one of the causes which induced the Congress to insert the following provision in the Act approved March 3, 1873, making appropriations for the Army:

"For improved machinery and instruments for testing American iron and steel: twenty-five thousand dollars."

Section IV of the Sundry Civil Act, approved March 3, 1875, provided in part:

"That for experiments in testing iron and steel, including the cost of any machine built for the purpose, the sum of fifty thousand dollars is hereby appropriated; and the further sum of twenty-five thousand dollars provided 'for improved machinery and instruments for testing American iron and steel' in the Act entitled 'An Act making appropriations for the support of the Army for the year ending June 30, 1874' approved March 3, 1873, is hereby continued and made available for such purpose; and that the President be, and is hereby authorized to appoint a board, to consist of one officer of the engineers of the United States Army, one officer of ordnance of the United States Army, one line officer of the United States Navy, one engineer of the United States Navy, and three civilians who shall be experts; and it shall be the duty of said board to convene at the earliest practicable moment, at such place as may be designated by the President for the purpose of determining, by actual tests, the strength and value of all kinds of iron, steel and other metals which may be submitted to them or by them procured, and to prepare tables which will exhibit the strength and value of said materials for construction and mechanical purposes, and to provide for the building of a suitable machine for establishing such tests: * * * *."

The Act approved July 31, 1876, provided:

"For completing experiments in testing iron, steel and other metals as provided in section four of the Act approved March 3, 1875, $19,396.98. And the board for testing iron and steel provided for in said section shall be discontinued from and after the expenditure of the amount herein appropriated."

The Sundry Civil Act, approved June 20, 1878, provided:

"That the Secretary of War is hereby authorized to cause the machine built for testing iron and steel to be set up and applied to the testing of iron and steel for all persons who may desire to use it, upon the payment of a suitable fee for each test; the table of fees to be approved by the Secretary of War, and to be so adjusted from time to time as to defray the actual cost of the tests as near as may be; * * * *."

The machine was installed at Watertown Arsenal and its operation was taken over by the Ordnance Department during 1881.

The appropriation acts approved in each year from 1880 to 1884, both years inclusive, provided "That the tests of iron and steel, and other materials for industrial purposes, shall be continued during the next fiscal year, * * * *." The acts from 1882 to 1884 provided: "That in making tests for private citizens the officer in charge may require payment in advance, and may use the funds so received in making such private tests, * * * *."

The Sundry Civil Act, approved March 3, 1885, provided:

"Testing machine, Watertown Arsenal; For caring for, preserving, using, and operating the United States testing machine at Watertown Arsenal, ten thousand dollars: Provided, That hereafter the tests of iron and steel and other materials for industrial purposes shall be continued, and report thereof shall be made to Congress: And provided further, That in making tests for private citizens the officer in charge may require payment in advance, and may use the funds so received in making such private tests, * * * *."

The omission of the words "during the next fiscal year" and the changing of the provision to "Provided, That hereafter the tests of iron and steel and other materials for industrial purposes shall be continued, * * * *" have been construed to be general legislation.

Thirty-one thousand and five hundred dollars of the appropriations made in the Acts approved March 3, 1873, March 3, 1875, and June 20, 1878, were used to procure an 800,000 pound testing machine designed and built by that eminent engineer, Mr. A. H. Emery. The contract was made June 19, 1875, and the machine was accepted February 8, 1879.

The report of the Board for Testing Iron, Steel and Other Metals was published by Congress in 1881.

Part of the appropriations named above was used to install apparatus for making chemical analyses of metals by Mr. Andrew A. Blair, employed by the board as chemist. During his work with the board Mr. Blair originated a few of the new methods of analysis which he contributed to the production of metals.

The results of tests made by the laboratory under the operation of the Ordnance Department were published annually by the Congress as *Tests of Metals* from 1882 to 1918, both years inclusive. Many of the tests have been used by professors and engineers for deducing formulae and have been quoted in text books and technical papers.

*Commanding Officer, Watertown Arsenal, Watertown, Mass.

Investigative Tests Authorized

The Sundry Civil Act, approved June 30, 1906, provided:

> "Testing machines, Watertown Arsenal: For the necessary professional and skilled labor, purchase of materials, tools, and appliances for operating the testing machines, for investigative tests and tests of United States material for constructions, and for instruments and materials for operating the chemical laboratory in connection therewith, and for maintenance of the establishment, $15,000.00."

This was the first authorization by law of "investigative tests." The language of subsequent annual appropriations has been practically the same.

Chemical analyses given in *Tests of Metals* from 1882 to 1885 were made by Capt. John Pitman, Ord. Dept., U. S. A. Chemical analyses do not again appear until 1893. Mr. E. K. MacNutt has been employed as a chemist since October 29, 1890. The first appearance of microphotographs was in 1898 and the measurement of temperatures by pyrometers is first mentioned in 1901.

The Sundry Civil Act, approved August 30, 1890, appropriated funds for additional chemical laboratory equipment; the Act approved June 11, 1896, appropriated for an impact testing machine; and the Act approved March 3, 1899, appropriated for a 100-ton Emery testing machine.

A Charpy impact testing machine was installed in 1914. Among other new installations are different types of impact testing machines, various fatigue testing machines, Brinell and Scleroscope hardness testing apparatus, research chemical equipment, microphotographic apparatus, 300,000-volt X-ray equipment for revealing defects in metals, diffraction X-ray apparatus for studying atomic structure of metals, cathode ray equipment, induction-crucible furnaces for making experimental heats of steel and electric furnaces for heat treating steel.

The laboratory is housed in two buildings and part of a third building that were erected between 1816 and 1820 for blacksmith, machine and gun carriage shops; it occupies about 18,213 sq. ft. of floor area.

The laboratory possesses a technical library, which is used also by students in the Ordnance School. Practical instruction is given by the laboratory to student officers in metallurgical chemistry, metallography, pyrometry, heat treatment, general metallurgy, X-rays and cathode rays.

The annual appropriation made by the Congress for the laboratory under "Testing Machines" was $10,000.00 from 1883 to 1890; $15,000.00 from 1891 to 1918, except that $35,000 was appropriated for 1909; $25,000.00 for 1919, 1925 and 1926; $50,000.00 for 1920 and 1922; $35,000.00 for 1921; $26,250.00 for 1923 and 1924, and $20,000.00 for 1927 and 1928. As labor and materials now cost practically twice as much as before the World War, the appropriation for "Testing Machines" is now really only about two-thirds of that made from 1891 to 1914, and less than that made from 1883 to 1890.

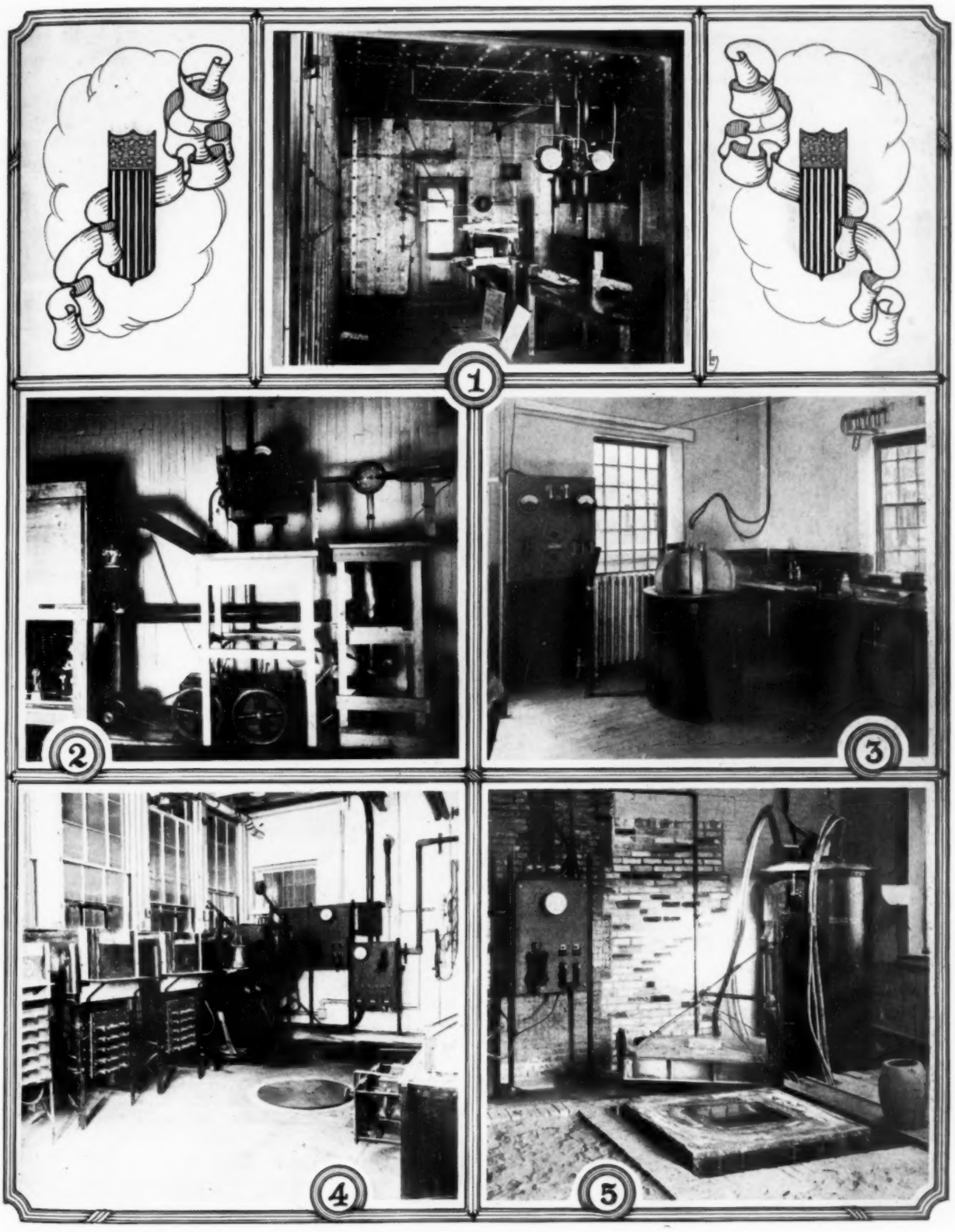
A laboratory for investigative and research work, particularly in metallurgy, cannot attain the constructive results of which its personnel and equipment are capable nor will its conclusions be accepted at real value unless it forms part of a steel making and productive plant, in which the laboratory personnel directs and controls the metallurgical production processes, which alone can give that personnel actual practical experience. This ideal condition has existed at Watertown Arsenal since its foundry has made cast iron and non-ferrous alloys for many decades and steel since 1904.

Scope of Materials Tested

The large scope of materials tested, as revealed by *Tests of Metals*, is interesting, especially when grouped according to industries.

ARMY AND NAVY

Rope for hawsers; anchor chain; Belleville and helical springs; copper cylinders for pressure gages; rubber and balata buffers; insulating materials; physical properties of iron, steel, bronze and other metals used in guns, gun carriages, rifles, pistols and projectiles; strength of hollow cylinders, 5 inches long, 3 inches exterior diameter and 1 inch bore, made of steel forgings for guns determined by interior hydraulic pressure; amount of initial strains left in gun forgings by different heat treatments; physical properties including modulus of elasticity of gun steels at various temperatures; measurement of force required to push projectiles with bands of different metals through the bores of 3.2-, 5-, 7-, 8- and 10-inch rifled guns and 12-inch mortars and of jacketed bullets through the bores of caliber .30 rifle barrels; determination of best annealing and heat treatment for different compositions of steel forgings for guns; increasing elastic limit of inner stave ring for 10-inch wire-wrapped Woodbridge gun by permanently enlarging bore by hydraulic pressure; hydrostatic test of section of 8-inch gun tube; strains produced in gun forgings when cooled from the bore; strength of caliber .30 rifle barrel sections measured by application of hydraulic pressure in bore; different methods of casehardening steels; physical properties and microstructure of steel castings, green, annealed and heat treated; physical properties and microstructures of various compositions of brass, bronze and alloyed bronzes; comparative strength tests of gun hoops containing "streaks" and free from "streaks" by application of interior hydraulic pressure, including physical properties and microstructure; structure of various steel ingots; subjected finished parts of gun carriages to proof tests, that is, to stresses greater than service stresses, such as axles, wheels, piston rods, recoil cylinders, retracting ropes and gun lever arms; cutting life of various tool steels; investigated strength of shrapnel cases of various designs and calibers by bursting with interior hydraulic pressure and longitudinal compression, and finding physical properties and microstructure; studied effect on gun steels of various alloys, such as nickel, chrome, vanadium, manganese, molybdenum, silicon and cerium; music and tempered steel wire and wire for wrapping guns; gun carriage wheels of different designs; compression tests of smokeless powder; detailed studies of causes of erosion of guns; preparation and testing of test specimens for standardizing testing machines in other plants; effect of aging on barium-calcium-lead alloy shrapnel balls; sands for sandblasting; determination of temperature of cores used in large steel castings; determination of heat treatment for steel castings; investigation of quenching media for



The Laboratory at Watertown Arsenal

1. Exposure room of 300,000-volt X-ray apparatus. 2. Cathode ray tube and equipment. 3. X-ray diffraction apparatus. 4. Electric furnaces for heat treatment of metals. 5. Induction furnace for 75-pound experimental heats.

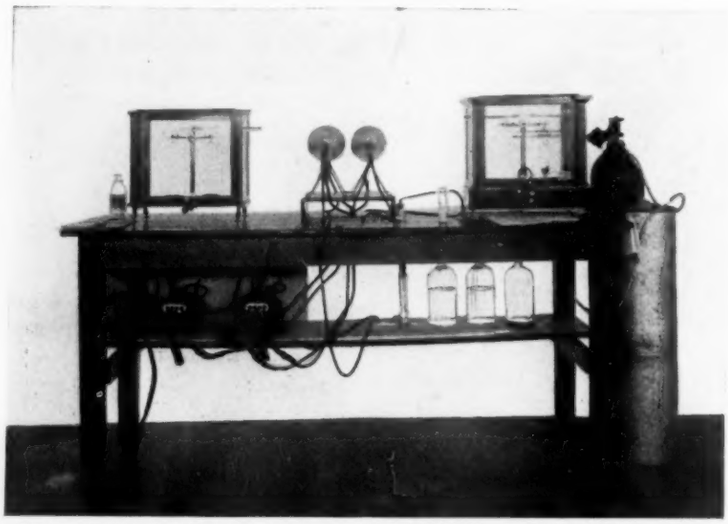
steel; establish forging practice for high grade alloy bronzes; based upon experience in private plants and in arsenal foundry, prepared complete and detailed practice for casting semi-steel shell; made experimental lots of track shoes of different compositions and heat treatments for test in service; and thermal expansion of various steels from 0° C. to 600° C.

Iron and Steel Manufacture

Rolling of ingots into rails and structural shapes; iron and steel wire; wire rope of various types; electrically welded wires and bars; chains from anchor to sash; tackle blocks; steel for reenforced concrete; barbed wire; wire rope sockets; steel bars for state prison; lifting hooks of different designs; shelf supports; endurance of rotating shafts; effect of rapidly alternating strains in iron and steel; and frictional resistance of roller bearings and journals.

Buildings, Bridges and General Construction

Numerous kinds of riveted joints; strength and other properties of many varieties of wood for different uses, such as columns and beams; iron, steel and concrete columns and beams of many types; many kinds of marble, natural and artificial stone, brick, tile and terra-cotta; different kinds of cement and many mixtures of concrete and kinds of reenforced concrete for various types of construction; brick piers; eye-bars; struts; adhesion of cut and wire nails in wood; strength of different kinds of glass; lag screws and expansion sleeve nuts; and shearing strength of concrete for Washington Monument.



Carbon Determination Apparatus at the Watertown Arsenal Laboratory.

Railroads

Locomotive tires, axles and side-rods; car axles, couplers and draft rigging; rails and stresses in rails in tracks; adhesion of spikes in wooden ties and rail joints.

Boilers

Riveted joints; physical properties of boiler plates; stay bolts and test of completed boilers.

Miscellaneous

Manila, hemp, cotton and other rope; cotton cloth and duck; cotton yarn; roller skates; electrical insulators; leather, cloth, rubber and steel belting and various types of belt lacings; parts of leather harness; calibration of steam and hydraulic pressure gages; bicycle spokes and tires; steel balls; curb bits; stirrups; weighing machines; monkey wrenches, engineers' wrenches and pipe wrenches and tongs; paper; automobile tires, hinges and spark plugs; gas and water pipe fittings; globe valves; water and steam fabric hose; copper and brass tubing; frictional and wearing qualities of various bearing metals, and shot lines for the U. S. Life Saving Service.

Throughout its existence, the laboratory has investigated the cause of failures in the Service and at the Proving Grounds that have been referred to it; the cause of many failures has been determined and corrective measures disclosed. The history of this class of work is most instructive, and the constructive results have more than justified the existence of the laboratory and its cost. Some of the failures revealed a regrettable reluctance to utilize the knowledge of the laboratory, such as the filling by electric welding of grooves cut erroneously at the muzzle of 240-mm. howitzers.

Principal Investigative and Development Work

The principal investigative and development work conducted by the laboratory has been:

(a) Thin armor plate. Study of ¼-inch, ⅜-inch and ½-inch armor made in this country and abroad of various compositions and subjected to different heat treatments shows that the resistance to penetration is more dependent on the final structure on the metal than on chemical composition.

(b) Investigation of permissible limits of sulphur and phosphorus in steel castings, forgings, rivets, plates and wheel tire and rail steel. Results show former limits can be increased with safety.

(c) Comparison of longitudinal and transverse tensile and Charpy physical properties of forgings.

(d) Determination of size, shape and notch for transverse Charpy test bars for adoption as standard.

(e) Development of 14-inch armor-piercing shot for impact at 30° from the normal.

(f) Practicability of chrome plating recuperator cylinders.

(g) Determination of so called "missing" carbon in steel.

(h) Development of two compositions of gun steels having markedly high Charpy, which should reduce fragmentation caused by detonation in bore of guns.

(i) Aging does not decrease physical properties of heat-treated gun steel.

(j) Investigated composition, tensile properties and Charpy tests of various stainless steels.

The principal research work undertaken is as follows:

(a) Determination of gases occluded in cast and forged steels and their probable effect.

(b) Shock resisting properties of 12 compositions of steel commonly used in ordnance, bridges and buildings,

aireraft engine parts, gears and for casehardening from —80° F. to + 1000° F. Results have proved most useful.

(e) Redetermination of Poisson's ratio, performed by Dr. P. W. Bridgman, Harvard University.

(d) Relationship between the work required to rupture a specimen statically in a tensile testing machine and that to rupture a specimen of the same dimensions and steel dynamically in a Charpy machine. The latter can be predicted within reasonable error from the former.

(e) Substitution of molybdenum for tungsten in high speed tool steels.

(f) Study of the arrangement of the atoms of the various elements composing steel, changes produced in the arrangement of the atoms by heat treatment, changes in crystals caused by cold working, presence of carbides and solid solutions of the elements.

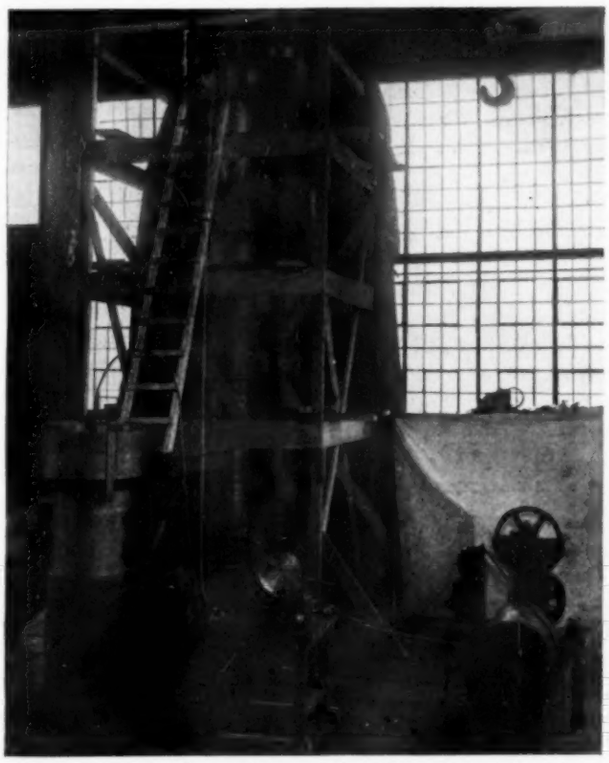
(g) Detection of cavities, cracks and other defects, in metals from films made by 300,000 volt X-rays and revision of foundry practice so sound castings can be made regularly. Now used commercially.

(h) Study of the effect of cathode rays on metals and other substances; increases hardness and changes structure of some metals. Study not completed.

(i) Based on the increase in strength given rifle barrels at the Springfield Armory during the past 75 years by firing a proof cartridge giving about twice the service pressure and to inner stave ring for 10-inch wire wrapped Woodbridge gun by permanently enlarging the interior and exterior diameters by interior hydraulic pressure, on increased elastic limit in tensile bars after plastic deformation, and on U. S. letters patent No. 894,428 of Mr. A. H. Emery, dated July 28, 1908, covering increase in elastic limit of metals produced by permanently enlarging both diameters by interior pressure, about 1,500,000 individual readings were obtained from experiments with hollow steel cylinders having bores 37-mm., 3-inches, 105-mm., 4.7-, 6-, 8- and 9.2-inches in diameter and having exterior diameters 1, 1½, 2, 2½ and 3 times the bore diameter, which cylinders were subjected to interior hydraulic pressure. Empirical formulae, deduced from the data, are used to design guns to be made by the cold-working process.

Most ingenuous equipment for generating, transmitting and applying high pressures to the bores of guns have been developed, which enable the process to be applied on a quantity production basis. Pressures as high as 140,000 pounds per square inch have been generated and applied.

The cold-working process enables gun bodies to be made in a single piece instead of assembling by shrinkage two or more concentric cylinders, thereby reducing the time required to make a gun body by one-third and also the cost. Guns made by the cold-working process are subjected to approximately twice the proof powder pressure, which gives each gun a drastic test. The cold-working of guns in a container enables the wall thickness at each section to be proportional to the powder pressure, thereby giving a more efficient distribution of metal.



Pump, control valve and gage, intensifier and container in which a 3-inch antiaircraft gun is being cold-worked at Watertown Arsenal.

Guns of two or more concentric cylinders can be made by the cold-working process without the accurate machining required for shrinkage.

Soaking guns at 300° C. after being cold-worked increased their strength about 8 per cent.

Forty-five guns and three removable liners have been made by the cold-working process, which is the adopted system for making guns.

(j) The practicability of casting field gun bodies in a single piece by the centrifugal process is being investigated, for if the process is successful, the amount of molten metal required to make the ingots for one tube and for one jacket for a 75-mm. field gun will make 3 bodies for the same gun. If centrifugal castings can be made satisfactorily, mobile guns and howitzers, exclusive of breech mechanisms, can be cast and cold-worked in less than one-third the time and at about one-half the cost of built-up guns forged from ingots. The progress to date is promising.

The *Tests of Metals* show that from 1882 to 1917, or during 36 years, the number of tests made and reported were as follows:

Period	Private Tests	For Government	Total
Total for 36 years	27,096	87,062	114,158
Average per year	753	2,418	3,171
Maximum in any year	1893— 2,366	1917— 5,431	1917— 6,404
Minimum in any year	1886— 237	1882— 664	1887— 1,398

The number of tests which the *Tests of Metals* from 1882 to 1918 show were made for the manufacturing arsenals is:

Picatinny Arsenal	0
Rock Island Arsenal	20
Watervliet Arsenal	115
Frankford Arsenal	136
Springfield Armory	735
Watertown Arsenal	13,891

The laboratory was largely engaged from its establishment until about 1910 in making routine tests, such as measuring the strength of materials and structures. That eminent ordnance engineer, Gen. Charles B. Wheeler, Ord. Dept., U. S. A., retired, during his command of Watertown Arsenal, from 1908 to 1917, materially increased the amount of investigative and research work, which increase has continued until this class now constitutes the major part of the activities of the laboratory.

General Wheeler installed a 30 kilogram-meter Charpy impact testing machine, the first in the United States, and required the making of a Charpy test of all cast and forged steel of which a tensile test was made. The data thus accumulated during about three years demonstrated the value of the Charpy impact test and resulted in its adoption by the Ordnance Department and by private industry. The analysis of these data made by Dr. F. C. Langenberg caused the British Iron and Steel Institute to award him a scholarship to investigate the Charpy impact of various compositions of steels from — 80° F. to + 200° F.

The large increase made in the plant and equipment of the U. S. Bureau of Standards resulted in the diversion to it from the laboratory of many tests. The average number of private tests has decreased in recent years to about 171 per year. This diversion has enabled the amount of investigative and research work, particularly for the Ordnance Department, to be increased.

The present work of the laboratory may be classified as follows:

(a) Routine testing, principally arsenal products and purchased materials.
(b) Private tests, made upon request of citizens and at actual cost.
(c) Control of metallurgical production processes in manufacturing plant.
(d) Investigative and research work.

The friendly cooperation of Dr. G. K. Burgess, Director of the Bureau of Standards, with the laboratory has materially assisted in preventing duplication of work by the two establishments.

Personnel of the Laboratory

As now organized, the laboratory is personally supervised by the Commanding Officer. Investigative and research work is controlled by Dr. F. C. Langenberg, technical expert, employed 50 days a year. The making of experimental heats of steel, all heat treating and pyrometry, are directed by Capt. S. B. Ritchie, Ord. Dept., U. S. A. Chemistry, metallography and cathode ray work, are directed by Dr. M. G. Yatsevitch. Physical testing, X-ray diffraction and X-raying of metals for defects, are directed by Dr. H. H. Lester. The parts of investigative and research programs that pertain to the class of work in each section are assigned to the director thereof. The cold-working of guns having been developed to a productive basis has been transferred to the manufacturing organization. The centrifugal process is being developed in the foundry by Capt. H. C. Minton, Ord. Dept., U. S. A., who uses the laboratory for metallurgical tests.

Membership of the personnel of the laboratory in the following technical and scientific societies, service on various committees thereof, and participation of the laboratory in some of the investigative work undertaken by the societies have kept the personnel in close touch with technical and scientific advances, namely: American Society for Testing Materials, Society of Automotive Engineers, National Research Council, American Institute of Mining and Metallurgical Engineers, American Society of Mechanical Engineers, American Iron and Steel Institute, American Society for Steel Treating. The last named society awarded the Howe Medal to Dr. H. H. Lester in 1925 and to Dr. F. C. Langenberg in 1926 for the results of research work done by them which was deemed the most valuable contribution made during the year to practical metallurgy.

The quantity and the value of the product of a laboratory are determined by the interest, the accuracy and the ability of its personnel and not by artistic buildings and abundant equipment of the best and latest design. The product of the laboratory at Watertown Arsenal has been influenced by the commanding officers and in particular by Colonel Wheeler, when in command from 1908 to 1917.

The policy of the Chief of Ordnance, U. S. Army, with respect to the laboratory has necessarily influenced its activities; Brig. Gens. Stephen V. Benét, D. W. Flagler and Maj. Gen. William Crozier in particular, endeavored to increase its usefulness, while in addition, Maj. Gen. C. C. Williams has followed the work of the laboratory personally with a constructive interest. General Williams' valuable suggestions and keen interest in the work have inspired the personnel to its best efforts.

Mr. James E. Howard was employed as Engineer of Tests from July 1, 1880, to February 28, 1910, and was commended almost annually by the Commanding Officer for his keen interest, originality and accuracy. Mr. H. L. Whittemore was Engineer of Tests from June 20, 1910, to July 17, 1912; Mr. Arthur T. Derry, Engineer of Tests, from September 10, 1912, to December 31, 1912; Mr. Arthur E. Russell, Engineer of Tests, from January 2, 1913, to April 4, 1914; Mr. John Hunter Nead, Metallurgist, from April 2, 1914, to November 1, 1915; and Dr. F. C. Langenberg, Metallographist and Director of Laboratories, from January 5, 1916, to January 8, 1927, had charge of the laboratory for the periods given. The laboratory achieved its greatest accomplishments, particularly in investigative and research work, under Dr. Langenberg, whose devotion to his profession, and whose analysis and keen interpretation of results, have made him preeminent in this field.

The wisdom of the Congress in establishing and operating the Watertown Arsenal Laboratory is proved by its marked contributions to the great progress made during the past 46 years by governmental agencies and private industries in various branches of engineering.

The American Society for Testing Materials*

Its Achievements In the Study and Standardization of Engineering Materials

THIRTY years ago, a group of engineers met in Philadelphia and formed an American Section of the International Association for Testing Materials, which had been organized in 1895 as a result of informal meetings over a period of fifteen years of various European workers in experimental engineering to study the properties of engineering materials. The American members soon appreciated that an independent organization offered opportunities for increased service, and in 1902 the members of the American Section brought about the incorporation of the American Society for Testing Materials, declaring its object to be:

> "The Promotion of Knowledge of the Materials of Engineering and the Standardization of Specifications and Methods of Testing."

The Society today is a national technical society of 4,300 members, including some 400 in foreign countries. The membership is drawn from all of the important industries of the country and includes: (1) Producers of raw materials, semi-finished and finished products in the metals, cement and ceramics, paints and oils, petroleum products, timber, coal and coke, rubber, textile and other fields; (2) such major groups of users of materials and products as railroads, the shipping industry, automotive industry, electrical manufacturing industry, public utilities, construction and building interests, and federal, state and municipal government departments; and finally, (3) the so-called "general interest" group, including consulting engineers, testing experts, educators, and technologists and scientists affiliated with government departments and technical schools. There are about 1,500 companies, firms, corporations, and industrial associations holding membership and in addition, about 800 other companies are participating in the Society's activities through personal membership held by employees of those companies. Testing laboratories, federal, state and municipal departments, universities and technical schools, technical societies and libraries, and individuals either having affiliations with these groups or entirely independent, make up the remainder of the membership.

The purposes of the Society are carried out broadly in two ways. The "promotion of knowledge of materials of engineering" is effected through investigations into the properties of materials by committees and members of the Society, and by joint researches with other groups, the results of which are presented at annual meetings as reports and papers which are discussed and published in Proceedings. The "standardization of specifications and methods of testing" is carried on through representative committees.

*By invitation of the officers and directors of the Army Ordnance Association, the American Society for Testing Materials will participate in the Ninth Annual Meeting of the Association at Aberdeen Proving Ground, October 6, 1927.

Standardization Work

The standardization work comprises in general: (1) the development of methods of testing materials, (2) the establishment of standard definitions and systems of nomenclature, (3) the formulation of specifications defining the quality and tests of materials and products, and (4) the preparation of recommended practices governing certain processes in the utilization of materials. The actual work of developing standards is assigned to standing committees, which function under carefully prescribed rules. These committees also conduct studies and research in the field of materials, either in conjunction with standardization or independent of it. Their reports are made annually to the Society.

Basic Principles.—The great complexity of our industries has tended to separate, in our industrial scheme, the producer and consumer of materials. In general, the consumer buys a finished material or product. The manufacture of these materials has become highly intricate and specialized; quantity production and economic considerations require relatively fixed processes, subject only to gradual modification and not to be varied at the option of the user. The consumer is not generally familiar with the processes of manufacture and their influence upon the properties of the materials he uses, while the producer is not familiar in detail with the problems that arise in the many and varied uses to which his material is put. However, only those standards for materials that are satisfactory to the two parties at interest can ever come into general commercial use. Accordingly, the Society from the beginning adopted the principle that the producer and consumer of materials must be brought together upon an equal footing, and all committees that are to develop commercial standards for materials are made up on the basis of representation from these two groups and from a third or "general interest" group, comprising independent authorities who have expert knowledge of the materials to be studied but who are not concerned directly with either their production or use. The "producer" group may not predominate on any committee.

A second basic principle is that standards shall be founded upon accurate knowledge of the properties of materials. Finally, it is a third principle that every opportunity shall be afforded for all interests to fully express their views, both in committees and before the Society, to present data bearing upon standards in course of development, and in every way to participate in the decisions that lead to standards. This is insured through the procedure that now governs committee and Society action on standards.

Procedure.—The steps in the development of a materials standard may be outlined briefly, as follows:

1. Agreement upon acceptable methods of determining the various properties of the material, which may involve a large number of comparative tests by various methods.

2. Agreement as to accepted definitions of terms relating to the particular materials and processes involved.

3. Discussion of requirements of proposed specifications. Here full account must be taken of the influence of manufacturing processes, the conditions to which the material will be subjected in service, and the particular properties of the material that enable it to give satisfactory service. Specifications for materials upon whose strength and reliability the safety of human life may depend must be especially carefully drawn and provided with adequate safeguards in testing and inspection. At times a compromise between the somewhat extreme views that may be held by producer and consumer is necessary in reaching at least a tentative agreement upon certain details, although the more clearly the problems involved are understood and the more complete are the technical data that can be presented on the subject, the more easily can a logical, rational agreement be reached.

4. The proposed standard is then presented to the Society for discussion and is published for at least a year as "tentative," when either its suitability will be established or desirable modifications indicated.

5. When a "tentative" standard either has been found acceptable or has been suitably revised, it may be proposed to the Society at an annual meeting for adoption as "standard," which requires a "letter ballot" vote of the Society membership.

It is recognized that occasional revisions in quality standards for materials are necessary to keep abreast of improvements in manufacturing processes, changes in design and construction, development of new materials, or for other reasons. A policy that has worked well has been to make it possible to revise tentative standards annually, but standards only once in three years.

Committee Organization.—The Society has organized 45 standing committees, upon which about 1,500 individuals, companies, laboratories, etc., are serving. These committees cover a wide range of engineering materials, as will be seen from the list of standards developed, appearing below. Many of these committees cover so large and diversified a field that extensive sub-committee organization is necessary.

The Support Afforded A. S. T. M. Standardization Work by Industry is manifested in various ways:

1. The support of and carrying on of research to further our knowledge of materials and to bring into existence the data that necessarily underlie the development of standards.

2. The contribution to the committee work of information and experience obtained in the actual production and use of materials.

3. The actual use of A. S. T. M. standards and the promulgation through purchase of standards, reprinting, incorporation in general industrial standards and the like.

In summary, it will be seen that the Society, with the help of industry, the government and educational institutions, is providing a forum for the discussion of materials and the development of equitable standards, and has at hand the complete "machinery" required to develop such standards from their first inception through all the stages of investigation and discussion to their final promulgation in industry.

What Has the A. S. T. M. Accomplished in Materials Standardization?

The answer to the question of what has been accomplished is the 515 standard and tentative specifications, methods of test and group of definitions relating to materials that the Society has developed. These are published in the Book of A. S. T. M. Standards, and the Book of A. S. T. M. Tentative Standards. A condensed list of materials and products covered in these standards is given below:

Steel Rails and Track Accessories.
Structural Steel.
Spring Steel and Springs.
Reinforcement Bars and Wire.
Steel Blooms, Forgings and Axles.
Steel Wheels and Tires.
Steel Castings.
Steel and Iron Tubes and Pipe.
Automobile Steels.
Boiler Steels.
Bar Steels.
Tool Steel.
Iron and Steel Chain.
Magnetic Properties of Iron and Steel.
Chemical Analysis of Steel.
Heat Treatment of Steel Objects.
Wrought Iron.
Pig Iron.
Cast-Iron Pipe.
Cast-Iron Wheels.
Malleable and Gray-Iron Castings.
Chemical Analysis of Pig and Cast Iron.
Ferro-alloys.
Ingot Copper.
Spelter, Lead, Nickel, Aluminum Alloys.
Brass and Bronze.
Solder and Babbitt Metals.
Copper and Brass Plates, Pipe, Rods.
Condenser Tubes.
Wire and Cables.
Screen Wire Cloth.
Chemical Analysis of Non-Ferrous Alloys.
Metallographic Testing.
Cement, Brick, Sewer Pipe, Drain Tile.
Lime and Gypsum.
Hollow Building Tile.
Refractories.
Concrete Aggregates.
Reinforced Concrete.
Paints and Oils.
Shellac.
Pigments.
Analysis of Pigments.
Petroleum Products and Lubricants.
Road Materials.
Coal and Coke.
Timber and Timber Preservatives.
Shipping Containers.
Waterproofing Materials.
Rubber Products.
Insulating Materials.
Textile Materials.

Mention may appropriately be made of the following materials for which specifications and tests are in course of development today:

Various metals and metallic products for service at high temperature.
High-tensile steel forgings.
Marine boiler steel.
Zinc-coated sheets, wires, pipe and other products.
Non-ferrous refrigerator tubing, sheet nickel, strip zinc, bronze and other castings, aluminum light-casting alloys.
Metallic materials for electrical heating.
Brick, hollow tile and other types of building units.
Refractories.
Paint pigments, shellac, varnish and linseed oil.
Naval stores.
Tests of petroleum products.
Forms of specifications for domestic fuel oil.
Road materials.
Bituminous waterproofing and roofing materials.
Grading rules for structural timber.

Officers of American Society for Testing Materials

Prof. H. L. Moore,
President.

T. D. Lynch,
Junior Vice-President.

Dr. G. W. Thompson,
Senior Vice-President.

C. L. Warwick,
Secretary-Treasurer.

Tests for electrical insulating materials.
Performance tests for rubber products.
Slate and building stone.
Test methods and tolerances for cotton fabrics, rayon, textile goods used in the electrical industry, woolen and knit goods and cords.

Perhaps one or two illustrations of the specifications developed by the Society will be of some interest to the readers of Army Ordnance. The steel industry was one of the first to be covered by the Society and one of the important specifications in this group is the one covering forgings. It is a basic specification covering many types of carbon-steel and alloy-steel forgings, the purposes for which the various classes may be used being set forth as follows:

Class A.—Forgings which may be welded or case-hardened.

Class B.—Mild-steel forgings for structural purposes, for minor ship fittings, etc.

Class C.—Mild-steel forgings for structural purposes, for ships, etc.

Classes D, E, F, G, H and I.—Various machinery forgings, choice depending upon design and upon the stresses and services to be imposed.

Classes K, L and M.—Various machinery forgings, choice depending upon design and upon the stresses and services to be imposed, and upon the character of machining operations necessary.

The specifications give the details concerning the process of manufacture, heat-treatment, chemical composition and physical requirements. These specifications, bearing the designation A 18-21, have come to be widely recognized, and one of the most used of the A. S. T. M. specifications.

More recently a group of specifications has been published covering ferro-alloys, such as: tungsten powder, spiegeleisen, ferro-manganese, ferro-silicon, ferro-chromium, and ferro-vanadium. These specifications, together with the methods of sampling and analysis, are based largely upon specifications prepared by the War Department.

Cooperative Relations

The subject of tests and specifications for materials is of interest to the entire field of engineering. The Society accordingly has necessarily been closely in touch with many organizations working in the industrial and engineering fields. It has been its policy to cooporate with those organizations interested in the development of materials standards, and for many years such cooperative relations have been maintained with the leading engineering societies of the country, with government departments and bureaus, with technical associations in the various industries, and with industrial and trade associations.

This cooperative work takes several forms:

1. In the carrying out of research and investigations of materials; the government laboratories in particular have been most helpful. Among these are the Bureau of Standards, Bureau of Mines, Bureau of Public Roads, Bureau of Chemistry, the Forest Service, Naval Engineering Experiment Station and Watertown Arsenal.

2. Many cooperating organizations have become affiliated with the Society, either officially as a group or unofficially through individual memberships; they appoint representatives to serve upon the committees and thus participate directly in the development of standards in which they are interested.

3. Joint committees are formed upon which various interested groups appoint representatives; such committees very generally succeed in bringing about concerted action among the cooperating groups.

Use of A. S. T. M. Standards

The Society cannot, of course, enforce adoption of its standards. Their use in industry must therefore rest upon their merits and upon the fact that the very way in which they have been formulated, jointly by producer and consumer, has presumably brought into existence a fair, equitable standard that can be readily introduced into industry to the advantage of both buyer and seller. The methods of test must be scientifically and technically sound and accurate, and at the same time practicable. The specifications must form an adequate basis both technically and commercially for the exchange of materials between producer and user.

Following are various ways in which the standards of the Society are used:

1. They are used without modification, as published by the Society, or as reprinted by various parties who have adopted them in their practice.

2. They are used by reference. For example, contracts will require material to conform to certain A. S. T. M. specifications or to be tested in accordance with A. S. T. M. methods, giving them by title; or the A. S. T. M. standard may be abstracted or quoted in full as a part of such contracts. The specifications of individuals, companies, governmental agencies and associations likewise refer to, abstract, or quote in full A. S. T. M. requirements. Building and other codes, standards for design and construction of machinery, buildings and other structures, roads, etc., and general construction specifications, will refer to A. S. T. M. standards for quality and tests of materials.

3. The standards, where not adopted outright, are used as the basis of specifications written by various units in industry. However desirable it may be to have all interests agree on a single standard where such a thing is possible, it is a fact that the tendency towards individuality in the writing of specifications is a strong one, so that the setting up of something that can be used as a guide to those who feel they must write their own specifications is a tremendous factor in preventing even greater diversification than exists today. An examination of many of the specifications for materials listed in the Directory of Commodity Specifications shows the undoubted influence of A. S. T. M. standards as the basis of specifications written by other agencies.

4. Moreover the A. S. T. M. specifications have been expressive of American practice and have therefore been of particular value as standards for export business in materials. Since 1916 the Department of Commerce has translated into French and Spanish 60 specifications covering materials active in export trade. These specifications have been distributed by the Department of Commerce among the American Consuls and Commercial Attachés in various countries and have also been used by American industries engaged in export business.

It is worth pointing out that standards are not always made for immediate use. As in all things, a start must be made. Often standardization projects are undertaken with the definite knowledge that much pioneer work must be done, and perhaps that much prejudice and opposition must be overcome before the benefits of the particular standards will be realized. Hence the first standards of a group developed under these circumstances can be expected to come only gradually into use, and be subject to frequent revisions as further progress is made. There are a number of examples of this kind among materials standards, but such standards nevertheless serve the very important purpose of concentrating thought and discussion upon some definite proposal that eventually will lead to effective standardization.

Industrial Significance of Standards for Materials

"Of what real value to producers and users of materials are these standard specifications?" This question was asked much more frequently in the past than it is today, for now many of our industries are keenly alive to the value of standardization. The benefits to both producer and consumer in the industries where standard specifications have been applied for any length of time are so evident and so well understood that the question can be answered convincingly. There are general advantages such as result from the thorough knowledge of the properties of a material and its performance in service; from the increased uniformity and reliability of the material; and from the tendency of quality standards to improve the whole output of a commodity of which any considerable portion is purchased according to such standards.

So far as the producer is concerned, there are certain advantages of particular importance. For example:

1. He is not compelled to supply, for essentially the same purpose, materials ordered to a variety of specifications that may differ by just enough to require separate production under each specification, involving many classifications in production, in stock piles and the like, with no commensurate benefit to the user.

2. Under standardization, with respect both to dimensional and quality standards, the manufacture, in times of general business depression when his orders are low and buying is practically at a standstill, can continue to produce "standard" material knowing that when business picks up there will be a market for it. In this way he keeps his plant running and his organization intact, avoids excessive labor turnovers, prevents large increases of overhead expense in relation to output, can frequently take advantage of favorable market conditions in purchasing raw materials, and in general maintains the efficiency of his operations. Such considerations as these are of great importance in that they substantially reduce the waste in industry, which is an economic burden upon the entire community.

3. The producer knows exactly what he is expected to furnish and how the material will be tested and inspected by the consumer, thus reducing to a minimum the possibility of misunderstandings, which are both vexatious and expensive.

These benefits to the producer are, of course, indirectly of advantage to the consumer. But there are certain other advantages that the consumer experiences in the use of standards, which may be enumerated as follows:

1. He can secure truly competitive bids on the same quality of material—a condition that is greatly to his advantage.

2. The details of purchasing are simplified and standardized—a matter of especial importance in large organizations.

3. Standard methods of test and inspection are of particular value in establishing a routine procedure for acceptance of material.

4. The greater uniformity and reliability of material purchased under standard specifications, and the fact that its properties are more thoroughly understood, make possible its more economic use.

It may be said in general that careful inspection and testing of material is necessary to insure proper deliveries under any specification. Often the manufacturer will furnish a certified statement that he has tested and inspected the material and that it meets the requirements of the specification, and such a certificate is generally accepted by the buyer as evidence of satisfactory delivery. While much more might be said regarding the enforcement of specifications, it is well to remember that standard specifications are not a general panacea for commercial ills, and that the thoroughly reliable producer who knows his product, carefully inspects it, and puts his reputation back of it, has just as important a place in industry today as ever.

The importance of standardization in relation to future industrial development can hardly be overestimated. Our industries within comparatively recent times have multiplied very rapidly, and not sufficient attention has been paid to the economies that are possible in simplifying types, design and dimensions of commodities, and in standardizing materials and practice. It is only recently that industry has become aroused to the necessity of applying these principles of standardization to problems of production, distribution and consumption. If these principles are properly applied, there need be little apprehension that standardization will weaken the incentive to originate, to invent, and to apply in the industries of the world new types, new materials and new processes—a criticism that is sometimes directed against standardization. Standardization has been accused of "fixing" practice in such a way as to retard desirable progress in industrial development. This has not been the experience of the A. S. T. M. in the field of materials; but it has been found that the introduction of materials standards has conserved time and energy for the study of new developments that otherwise would be occupied with routine matters, and that standards of quality and tests for materials are readily modified from time to time as new developments take place.

Promotion of Knowledge of Engineering Materials

The discussion so far has been confined to that side of the Society's work having to do with the development of materials standards. Another phase of the Society's work deals directly with advancing the knowledge of engineering materials. The importance of extending and amplifying this knowledge cannot be emphasized too strongly for upon the efficient economic use of materials depends in no small measure the progress of our civilization. This function

of the Society's work is carried on through investigations and researches by its committees and by joint committees with other organizations, through the collection and publication of data on various subjects, and through the presentation and discussion at meetings of papers on the properties and tests of materials. The committee reports and papers are published in annual proceedings and in this way extremely valuable data are widely disseminated.

Several typical examples of researches of this kind that we believe will be of particular interest to readers of Army Ordnance are selected from upwards of fifty research projects of the Society.

Corrosion.—One sees published from time to time rather staggering estimates of the annual loss due to corrosion of metals. The problem has been one of major study by the A. S. T. M. for many years. Studies of the efficacy of various types of protective coatings, especially paints, were begun over twenty years ago, culminating in the now well-known tests of a number of paints applied to the bridge that carries the Pennsylvania Railroad across the Susquehanna River at Havre de Grace. In the past decade the Committee, of the Society, on Corrosion of Iron and Steel has carried on extensive exposure tests of uncoated sheets of iron and steel of various known compositions, under outdoor atmospheric conditions, at three localities: Pittsburgh, Pa., Fort Sheridan, Ill., and Annapolis, Md. The sheets in the acid, smoky atmosphere of Pittsburgh failed first, followed by many of those at Fort Sheridan, selected originally for its rural atmosphere, which subsequently became semi-industrial. Sheets at Annapolis in comparatively salt atmosphere are still under observation. These tests to date have shown that the presence of copper in all of the various types of metal has greatly increased their resistance to corrosion under atmospheric exposure.

Seven years ago the same committee started tests of samples from the same iron and steel sheets totally immersed in open mine water at Calumet, Pa., in saline water at Annapolis and in city water at Washington, D. C. While all the material thus exposed has not failed, it has shown that under these three widely varying water exposures the presence of copper does not give increased resistance to corrosion. Tests in ocean water to determine the effect of corrosion on steel sheet plate, with and without copper, when riveted with rivets of iron and steel with varying copper contents, have recently been started.

The same committee of the Society has now started comprehensive field tests at five widely separated localities representing quite different atmospheric conditions on metallic coated sheets, wire and wire products, structural shapes, pole line hardware and miscellaneous castings.

Another committee is studying resistance to corrosion of a number of the non-ferrous metals and alloys, their work having begun with a study of the practice of corrosion-resistance testing, involving total immersion, alternate immersion, spray and accelerated electrolytic tests. A third committee is determining the relative life of the higher grade non-ferrous screen wire cloths when exposed to various atmospheric agencies such as corrosion and wind as they exist in different localities and climates.

Effect of Sulphur and Phosphorus on Steel.—An extended study to determine the effect of sulphur and phosphorus in various types of steel has been carried on for the past half dozen years by a joint committee formed by eleven national societies and government bureaus interested in the problem. The commercial importance of this problem, particularly as to the effect of sulphur, was emphasized during the war when, because of fuel restrictions, it was necessary, in order to procure steel in the great volume required, to raise the allowable limits of sulphur and of phosphorus in commercial specifications. After the war these limits in the great majority of cases were brought back to their original lower values, but the discussions surrounding this matter pointed clearly to the desirability of a more complete investigation of the effect of these elements on steel as commercially produced than had heretofore been made.

Tests to determine the effect of sulphur in commercial rivet steel and commercial steel plate have been completed. Studies of the effect of sulphur on an important type of forging steels are now under way. The material will be tested in the annealed and quenched-and-drawn conditions. Because of the commercial importance of this type of material and the exacting uses to which it is put by the great variety of industries, this part of the investigation is considered very important.

To determine the effect of phosphorus, the committee has started with the most important phase of that problem, namely, the determination of the effect of phosphorus in acid open-hearth cast steel. This is a problem of distinct interest to foundrymen and users of castings.

In all cases the material has been manufactured in accordance with good commercial practice but under the direct supervision of the committee. Complete information regarding melting, rolling, forging or casting practice, and complete chemical analysis of the steels, have been secured. The tests have been carried out through the courtesy of Watertown Arsenal and the Naval Engineering Experiment Station at Annapolis, Md.

Magnetic Testing.—The Society has for a number of years been investigating the magnetic properties of various types of steel, seeking to establish the fundamental relationships connecting these magnetic properties with the mechanical properties of the steels and to develop test methods best suited to bring out the significant variations in magnetic properties as affected by the composition and the thermal and mechanical history of the material. The problem is one of particular interest in that it covers a means for the non-destructive testing of iron and steel. Although early studies of the magnetic properties of steel and their relation to familiar mechanical properties dates back over 20 years, it is only within comparatively recent years that some of the inherent possibilities of this method of testing have begun to be realized. At the annual meetings of the Society this year and last there have been presented the results of studies of the properties of high-speed steel which have indicated clearly the possibility of routine inspection of such material by magnetic testing that distinguishes between proper and improper heat treatments. Some recent developments relating to magnetic analysis made by means of the cathode ray oscillograph and the use of the duroscope, an apparatus for magnetic determination of durability of steels, have been described by members of the Society's committee on this subject. An important commercial application of magnetics is now being made to the inspection of steam turbine bucket wheels,

by which without destroying the wheel the homogeneity and soundness of the steel may be quite accurately determined.

Metal Radiography.—A further method that has been developed in recent years for the non-destructive testing of materials is a method employing the X-ray. It has been found that X-rays if powerful enough will penetrate metal such as iron and steel to a thickness of several inches; in fact photographs have successfully been made through metal 4 inches thick. These photographs show whether the material, such as in a casting, is homogeneous throughout or whether there are blow holes or other openings and defects within the casting.

Much of the work in developing this method has been carried out at Watertown Arsenal. This method is of especial importance since by means of it the very material that is to go into service may be tested before making the installation. This has proved of considerable value in testing castings for use in power plants, where a defect may have very serious consequences.

The art of radiography has progressed very rapidly in recent years, so that it was possible for the Society to issue in 1926 Methods for Radiographic Testing. The general subject of X-rays has received considerable attention, and at the recent annual meeting a lecture on "X-rays in Industry" was delivered by Dr. George L. Clark, Professor of Applied Chemical Research and Divisional Director of the Research Laboratory of Applied Chemistry in the Massachusetts Institute of Technology. His investigations would indicate that the X-ray bids well to become one of our most reliable methods of testing and that the time is not far distanct when the X-ray will be the most fundamental method of examination of materials.

In all of this investigative work, there is constantly before the committees of the Society the desire to ascertain the facts. It is the endeavor, as recently expressed by the President of the Society, to see that this spirit of research, an intellectual curiosity to find out the truth, pervades all of the Society activities—not alone in the distinctively investigative work but as well in the specification work, where the importance of seeking the best possible adjustment of differences of opinion between producers and consumers, based upon facts and sound engineering judgment, can hardly be over-emphasized.

The activities of the Society, of course, appeal in different ways to different groups. Some are interested primarily in the extension of the knowledge of materials, others in the more strictly industrial and commercial applications as seen in methods of test and specifications. To the Army Ordnance Association and its members the work of the Society will no doubt appeal in both ways. The existence of commercially acceptable specifications for materials, sound technically, affording adequate protection to the consumer and at the same time entirely practicable to the producer, is an important factor in the Army Ordnance Association program of Industrial Preparedness for National Defense; and the standardization work of the A. S. T. M. has resulted in the development of just such specifications and methods of test. It has been very gratifying to observe the fine spirit of cooperation that has brought industry and the Government closer together in a study of these problems, and valuable progress has been made in coordinating Government and general industrial specifications for materials. The Society has had the helpful cooperation of industry and the various governmental departments in both its investigative and standardization activities, and it is the Society's desire to make the A. S. T. M. standards available for the purposes of the program of Industrial Preparedness to whatever extent is possible. The cooperation of the Army Ordnance Association in any aspects of the Society work that may be of particular interest will be most welcome.

Officers

The officers of the Society are as follows: *President*, H. F. Moore, Professor of Engineering Materials, University of Illinois, Urbana, Ill.; *Vice-Presidents:* G. W. Thompson, Chief Chemist, National Lead Co., Brooklyn, N. Y., and T. D. Lynch, Manager, Materials and Process Engineering Department, Westinghouse Electric and Manufacturing Co., East Pittsburgh, Pa.; *Past-Presidents:* F. M. Farmer, Chief Engineer, Electrical Testing Laboratories, New York City, W. H. Fulweiler, Chemical Engineer, United Gas Improvement Co., Philadelphia, and J. H. Gibboney, Chief Chemist, Norfolk and Western Railway Co., Roanoke, Va.; *Members of Executive Committee:* Cloyd M. Chapman, Consulting Engineer, New York City; F. O. Clements, Director of Research, General Motors Corporation, Detroit, Mich.; W. F. Edwards, Director of Laboratories, U. S. Testing Co., Inc., New York City; W. H. Klein, General Manager, Southern Division, Pennsylvania-Dixie Cement Corporation, Chattanooga, Tenn.; F. C. Langenberg, Vice-President, Climax Molybdenum Co., and Consulting Engineer for U. S. War Department, New York City; W. B. Price, Chief Chemist and Metallurgist, Seovill Manufacturing Co., Waterbury, Conn.; H. T. Shelley, Secretary and Manager, Eastern Clay Products Assn., Philadelphia; and F. N. Speller, Metallurgical Engineer, National Tube Co., Pittsburg, Pa.; *Secretary-Treasurer*, C. L. Warwick.

THE AMERICAN SOCIETY FOR TESTING MATERIALS
THE SOCIETY OF AUTOMOTIVE ENGINEERS

and

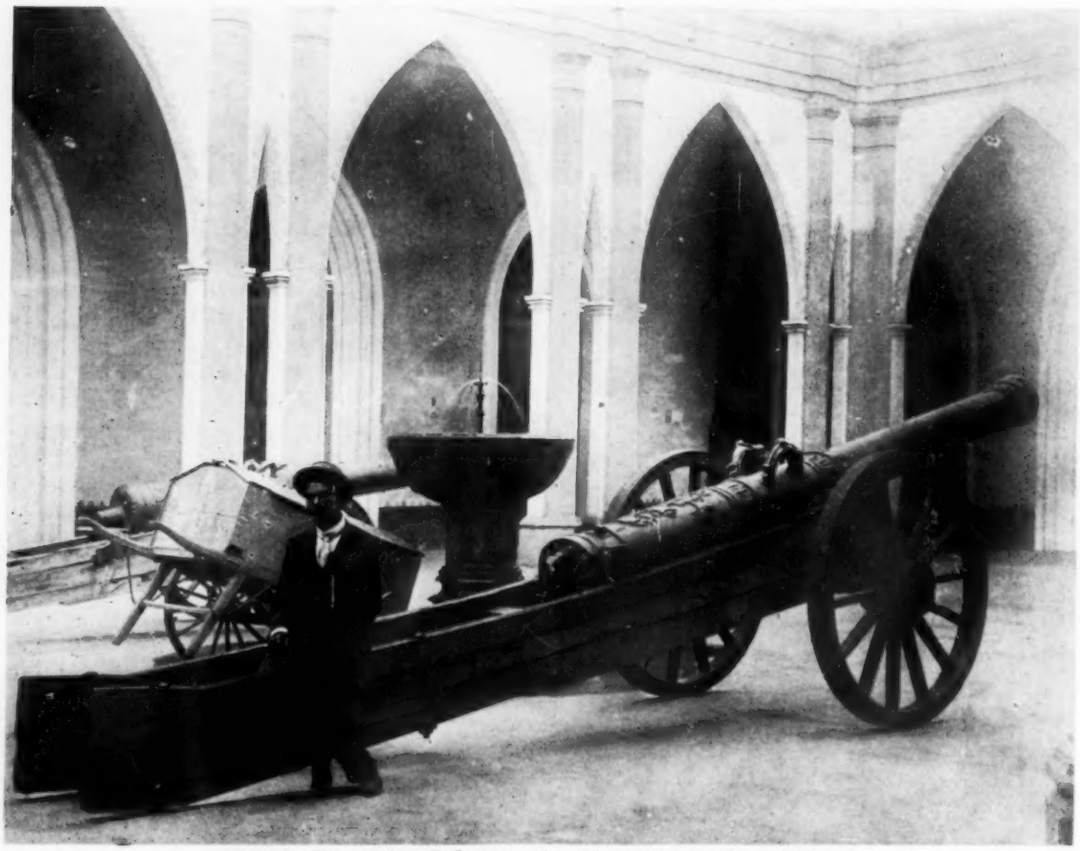
THE MILITARY ORDER OF THE WORLD WAR

WILL PARTICIPATE IN

THE NINTH ANNUAL MEETING OF THE ARMY ORDNANCE ASSOCIATION

Aberdeen Proving Ground, Md., October 6, 1927.

Ordnance News in Pictures



Historic Venezuelan Ordnance—An old cannon on view at Caracas.

British Tanks of the Southern Command of Mechanized Forces at Tidworth, lined up for inspection by Sir Laming Worthington Evans, Secretary of State for War.

The Military Order of the World War*

A Patriotic Organization of Officers Who Served in the Great War

IN September, 1920, an organizing convention was held at Detroit, Michigan, by a group of officers who had held Federal commissions during the World War and had incorporated under the name of "American Officers of the Great War."

This convention brought together delegates from a large number of chapters which had been organized in different parts of the country. A constitution was adopted, national officers elected and the name of the organization officially changed to the Military Order of the World War.

The new organization elected as its first Commander-in-Chief, Maj. Gen. Geo. H. Harries, whose service in the Army dates back to the country's Indian troubles. He served in the Spanish American War as Colonel and in the World War as a General Officer. His first service in France was in the 13th Corps of the 2nd French Army and he was later in command of Base Section No. 5. Immediately after the Armistice he was relieved from duty at Brest and detailed to Berlin, Germany, as a member of the two Inter-Allied Commissions on the repatriation of Allied prisoners. He also became chief of the U. S. Military Commission in Berlin and continued on duty there until the Commissions were withdrawn toward the end of 1919. General Harries held the high post of honor as Commander-in-Chief of the Order with untiring devotion until 1925 when he was succeeded by Maj. Gen. Mark L. Hersey, U. S. A. (Ret.), who at the time of his retirement was Commandant of the First Corps Area and stationed at Boston.

General Hersey graduated from West Point in 1887 and his first assignment to Army duty was at Fort Mojave, Arizona. From 1891 to 1895 he was Professor of Military Science at the University of Maine and later detailed to similar duties at Harvard University. For five years he was Chief Supply Officer of the Philippine Constabulary, and saw service on the Mexican border. During the early part of the World War General Hersey was on a special mission. In 1917 he was appointed Brigadier General and assigned to the command of the 155th Infantry Brigade of the 78th Division which outfit he took to France. Later he was promoted to Major General and assigned to the command of the Fourth Division, well known as the "Fighting Fourth."

The present Commander-in-Chief of the Order is Maj. Gen. Douglas MacArthur, Commanding General of the Third Corps Area with headquarters at Baltimore. General MacArthur graduated from the U. S. Military Academy in 1899 and rose rapidly through the various grades. General MacArthur saw service in the Philippines, in Mexico, and was appointed Chief of Staff of the 42nd Division in 1917. He commanded the 85th Infantry Brigade in 1918 and participated in Champagne-Marne and Aisne-Marne defensives, St. Mihiel, Pannes and Meuse-Argonne and Sedan offensives and was with the Army of Occupation in Germany. He has a most enviable war record and received his appointment as Major General in January, 1925.

OBJECTIVES OF THE MILITARY ORDER OF THE WORLD WAR 1927

PREPAREDNESS

DIRECTLY: By augmented effort to make effective the full requirements of the National Defense Act of 1920; *and its related factors, specifically indicated as follows:*

1—*To assist in making effective a plan for mobilization of material and industrial resources.*

2—*To assist in making effective the full intent of the Limitation of Armament Treaty (the 5-5-3 agreement) so that the U. S. Navy will be on a par in all respects with that of Great Britain.*

3—*To assist in making effective an Air Force and Chemical Warfare program to that degree contemplated by the National Defense Act of* 1920, *together with keeping abreast of the times in commercial air activities.*

4—*To stimulate organization and training of the C. M. T. C. and R. O. T. C. in schools and colleges and to provide the public with information thereon that it undoubtedly needs and would welcome.*

INDIRECTLY: By opposing those agencies seeking to destroy or make impotent the National Defense Act of 1920 *and its related factors.*

REHABILITATION OF VETERANS

To bend every effort through National Headquarters of the Order, Chapters, and by cooperation with the U. S. Veterans Bureau, and patriotic organizations in supporting such legislation and other activities, directly and indirectly, having a view of further improving the conditions of the disabled veterans of the World War.

Purposes of the Order

The purposes of the Order were enthusiastically proclaimed to be such as would carry the organization on successfully as a real working unit with well defined objectives which were briefly, but clearly, set forth in the Preamble to its Constitution which reads as follows:

"To cherish the memories and associations of the World War waged for humanity;

*By invitation of the officers and directors of the Army Ordnance Association, the Military Order of the World War will participate in the Ninth Annual Meeting of the Association at Aberdeen Proving Ground, October 6, 1927.

"To inculcate and stimulate love of our country and the flag;

"To ever maintain law and order, and to defend the honor, integrity and supremacy of our National Government and the Constitution of the United States;

"To foster fraternal relations between all branches of the Military and Naval Services;

"To promote the cultivation of Military and Naval Science and the adoption of a consistent and suitable Military and Naval policy for the United States;

"To acquire and preserve records of individual services;

"To encourage and assist in the holding of commemorations and the establishment of memorials of the World War;

"And to transmit all of these ideals to posterity;

"We unite to establish the Military Order of the World War."

Maj. Gen. George H. Harries, U. S. A., Rtd., First Commander-in-Chief, Military Order of the World War.

The Detroit Convention decided to move National Headquarters to New York City where it is now located at 52 Vanderbilt Avenue, with thirty-nine chapters located in many of the larger cities of the United States, a chapter at Paris, France, one at Honolulu and another in the Canal Zone. The present National Officers are: Commander-in-Chief, Maj. Gen. Douglas MacArthur; Honorary Commanders-in-Chief, Maj. Gen. Geo. H. Harries, and Maj. Gen. Mark L. Hersey; Vice Commanders-in-Chief, Rear Adm. H. T. Mayo and Maj. Gen. Wendell G. Neville; Junior Vice Commanders-in-Chief, Brig. Gen. Palmer E. Pierce, Lt. Col. Francis E. Drake, Maj. Edward W. Moore, Maj. Walter M. Pratt; Treasurer-General, Col. Thatcher T. P. Luquer; Judge Advocate General, Col. David A. Reed; Surgeon-General, Col. P. J. H. Farrell; Chaplain-General, Lt. Col. Thomas J. Dickson; Historian-General, Maj. Wm. J. Hammer; Adjutant General, Capt. Geo. L. Darte. The General Staff consists of Brig. Gen. S. Herbert Wolfe, Maj. Wm. L. Symons, Col. Martin H. Foss, Col. Clarence P. Franklin, Col. Redfield Proctor, Ens. Malcolm C. Sargent, Col. Jenks B. Jenkins, Brig. Gen. Allison Owen and Comdr. Robert E. Tod.

Its Position Well Defined

The Military Order of the World War bears the same relation to the American Legion as the Society of the Cincinnati, composed of descendants of officers who served in the War of the Revolution, does to the Sons of the Revolution, whose membership is composed of descendants of both officers and enlisted men; and the same relation that the Military Order of the Loyal Legion, composed of officers (or male descendants) who served in the Civil War, bears to the Grand Army of the Republic, composed of both officers and enlisted men.

Thus it is seen that the Order has a well defined and logical place in the veteran organizations' history of the United States. Its purposes were stressed by General Pershing at the Order's sixth National Convention at Philadelphia last year when he, in referring to its first Commander-in-Chief, General Harries, said, "I recall his oft repeated declaration regarding the spirit of the Order, which he expressed by saying, 'It believes in giving something to the country instead of taking something from it.'"

General Pershing continued saying, "The aims and purposes of the Order were conceived by patriotic men. To cherish the memories of the World War is to transmit to posterity the idea of loyalty. This thought seems all inclusive for without it the honor, integrity and supremacy of our government and the constitution would fade. The splendid services, as part of the nation's armed forces under the stress of war, rendered by the members of this Order loudly proclaim their patriotism. Since the war their active interest in our system of national defense is still further proof. The obligations of peace are of vital importance in this regard, as we now know we must not fail again in our preparation against a like emergency."

Maj. Gen. Mark L. Hersey, U. S. A., Rtd. Second Commander-in-Chief, Military Order of the World War.

An Active Organization

The Order is an active organization with a wide scope of endeavor and is particularly devoting itself to those vital national problems which have to do with the principles and ideals embodied in the Constitution of the United States.

It is particularly interested in the matter of adequate national defense, combat of radical and subversive activities within the confines of our own country, and such legislation (it is not in politics) as is for the best interest of our country and the relief of those who have honorably served in time of national emergency.

If the Order can be an effective factor—and it is believed it has already accomplished much in this respect—toward helping to carry out effectively the intent and purposes of the Defense Act of 1920 and the placing of our country in a position

of real security—it feels that in itself alone is sufficient reason for its existence and continuance. On another page of this article will be noted the concrete objectives of the Order which it is consistent to believe should meet with the approval and active support of every active service officer who wore the uniform during the World War.

It is not a monetary beneficial organization, the satisfaction and pride in membership being the knowledge that an officer who has served in the world's greatest conflict still "carries on" in civil or military life. It believes it has a duty to perform now quite as much as in 1917-18.

Except in the matter of good works there is no competition between the Military Order of the World War and other bodies of military origin. Its relationship with all of them is harmoniously fraternal.

Maj. Gen. Douglas MacArthur, U. S. A., Commander-in-Chief, Military Order of the World War.

It seems well to stress the fact, at this point, that this Order is the only officers' society in which membership is confined exclusively to those who served in the World War, and the further fact that it is the inevitably ultimate organization for all who served honorably as officers in that conflict.

As yet the Order has made no provisions for membership by inheritance and this matter will no doubt be one that will be definitely decided upon within a few years.

The Order has resolved that insofar as it can make it so, no man of our men shall ever go to war again while ignorant of warlike methods and therefore incapable of defending either himself or his country; that the nation which calls him to its most hazardous service shall give him a fighting chance by teaching him how to prepare for deadly combat with those who inevitably will (just when no man can predict) seek to destroy our institutions and subjugate our people. This is not to be construed that the Military Order of the World War is militaristic—it is the very antithesis of that—it believes in peace, but it must be a real peace—a peace with absolute security for our Nation and our citizens and not a peace-at-any-price.

To be eligible for membership an applicant shall be a man of good moral character and reputation and have honorably served in the Army, Navy or Marine Corps of the United States or their Allies, during the World War, prior to the Armistice, November 11, 1918, and after the entrance into the War of the country in whose forces he served; and who had been commissioned an officer prior to the promulgation of peace with Germany, July 2, 1921.

Capt. George L. Darte, Adjutant General, Military Order of the World War.

Membership is restricted to the following classes: Active members are those who fulfil the requirements of eligibility and pay annual dues. Honorary members are those, other than citizens of the United States who being eligible for active membership shall, on nomination by any chapter or the General Staff, be elected to membership. They enjoy all the rights and privileges of active members except those of voting and holding office. Memorial members are those who would have been eligible, but who while serving their country during the World War were called upon to make the supreme sacrifice and laid down their lives for humanity. Such members may be elected by the General Staff on nomination by a chapter and their names shall be borne on a special roll and shall be known as Companions through Remembrance.

Local Chapters of the M. O. W. W.

The chapters and their commanders are the following: ARMY WAR COLLEGE, Maj. Condon C. McCornack, Commander; AURORA, ILL., Lt. Layard G. Thrope; BALTIMORE, MD., Col. Harry C. Jones; BANGOR, ME., Maj. Calvin M. Thomas; BOSTON, MASS., Lt. Col. Howard Emerson; CANAL ZONE, Col. Alexander Greig, Jr.; CHICAGO, ILL., Capt. Elmer W. Rietz; DETROIT, MICH., Col. Burt R. Shurly; DISTRICT OF COLUMBIA, Brig. Gen. Samuel D. Rockenbach; FORT BENNING, GA., Col. Wait C. Johnson; MANCHESTER, N. H., Maj. Eugene T. Sherburne; HARRISBURG, PA., Maj. H. H. Barnhart; HARTFORD, CONN., Maj. E. Terry Smith; HONOLULU, HAWAII, Col. Adna G. Clarke; KNOXVILLE, TENN., Lt. Col. Thomas J. Wyrick; LEXINGTON, KY., LOUISVILLE, KY., Lt. J. G. Caldwell, Jr.; MIAMI, FLA., Capt. Harvey White; NEW HAVEN, CONN., Lt. Col. Herbert H. Vreeland, Jr.; NEW ORLEANS, LA., Lt. Frank S. Oser; NEW YORK, Maj. Gen. Robert Lee Bullard; BUFFALO, N. Y., Capt. Frederick W. Woody; OMAHA, NEB., Col. W. R. Brooks; PARIS, FRANCE, Lt. Col. Francis E. Drake; PHILADELPHIA, PA., Col. Lewis S. Sorley; PITTSBURGH, PA., Maj. Walter H. Kelly; PORTLAND, ME., Maj. Frank E. Lowe; PORTLAND, ORE., Lt. Col. E. C. Mears; PROVIDENCE, R. I., Brig. Gen. Charles T. Glines; COLUMBIA, S. C., Maj. A. E. Legare; ROCHESTER, N. Y., Capt. Ronald C. Hands; ST. LOUIS, MO., Comdr. G. C. Hall; ST. PAUL, MINN., Col. Thomas W. Hammond; ST. PETERSBURG, FLA., Capt. Framer B. Potter; SAN DIEGO, CAL., Comdr. Harlow T. Kays; SAN FRANCISCO, CAL., Capt. Frank M. MacGraw; TOPEKA, KANS., Col. W. McD. Rowan; VERMONT,

Maj. Charles N. Barbert; WORCESTER, MASS., Lt. Jacob Reed; CLEVELAND, O., Col. Hubert J. Turney; HEADQUARTERS CHAPTER, composed of members-at-large.

Some of Its Activities

The Order has been and is particularly active in matters pertinent to the welfare of our country and while the details cannot be described fully the following items present a general idea of the scope of its activities during the last two years: (1) Continued national and chapter activities to make effective the National Defense Act of 1920. (2) Continued support of adequate appropriations for the Army of the United States in all its component parts. (3) Support of development of the Air Corps, maintenance of an efficient naval and marine corps reserve, officers reserve, R. O. T. C. and C. M. T. C. (4) Navy Day cooperation. (5) National and chapter cooperation in the matter of Disabled Emergency Army Officers Legislation. (6) Cooperation with the U. S. Veterans Bureau and assistance of disabled and needy veterans. (7) Activities with a view to the passing of the bill to equalize the pay of retired officers of the Army, Navy and Marine Corps, Coast Guard, Coast and Geodetic Survey, and Public Health Service. (8) Particular important activities in interesting the A. F. of L. in the work of the C. M. T. C. (9) Support of the McLeod Bill, formerly H. R. 225, the purpose of the bill being "to curb the activities of individuals and organizations preaching the doctrines of Bolshevism in the United States." (10) Activities, particularly in New York City, to prevent certain well known subversive organizations to obtain the use of public school buildings to stage their meetings. This effort resulted in the Superintendent of Schools of New York City prohibiting the use of school buildings to several of these organizations. (11) Cooperation with the American Legion and the National Civic Federation with a view to "getting out the vote" and awakening the citizens to a better realization of the citizenship responsibilities. (12) Activities and information in connection with the American cemeteries overseas. (13) Activities combatting the fight against military training in schools and colleges brought about by the so-called Committee on Militarism in Education and other pacifistic groups. (14) Cooperation nationally and through chapters in the movement to establish an endowment fund of $2,000.000 for relief of abandoned Philippine children. (15) Activities against attempts of several well known subversive organizations towards pacifistic control of Armistice Day in certain sections of the country. (16) Activities against further elasticity in the matter of immigration and support of a movement in favor of alien registration. (17) Cooperation with the National Civic Federation on "Good Citizenship" Conference. (18) Cooperation in the work of the Battle Monuments Commission, on which committee are several of its members. (19) Cooperation with the Government of France through Paris Chapter in the plan for the official reception of the Governor's Foot Guards at Hartford, Putnam Phalanx of Connecticut, and the Richmond Blues, in France in 1926. (20) Participation of chapters in Memorial Day services as well as participating in ceremonies at American cemeteries abroad on Memorial Day. (21) Cooperation in a movement that resulted successfully in the establishment of a memorial in St. Nazaire, France, commemorating the arrival of the first American troops in France on June 26, 1917. The Order was directly represented on the occasion of the unveiling, June, 1926. (22) Information through the columns of the National Bulletin published by the Order disclosing various movements and programs of certain well known subversive and radical organizations and individuals whose activities are believed to be inimical to the welfare of the nation. (23) Cooperation in a fund to preserve "Old Ironsides." (24) Supplying information on subversive organizations to many patriotic organizations and individuals. (25) Direct national and chapter activities as well as cooperation with the national committee of veteran and patriotic organizations in support of the U. S. Government plans for the Defense Test of July 4, 1925. (26) Activities to combat the revival for the recognition of Soviet Russia. (27) Activities resulting in the denial of the right of Mr. Frederick J. Libby, Executive Secretary of the National Council for Prevention of War, to speak before the public schools of the District of Columbia. (28) Activities in printed matter discussing the radical phases of the proposed Child Labor Amendment. (29) Cooperation in the promotion of the successful result in the American Legion Endowment Fund of $5,000,000 to take care of the parentless children of veterans, as well as to provide for the proper maintenance of the children of veterans who are unable to provide for their education. (30) Instigated the action by the State of New York and the Federal Government against *The Daily Worker* (official organ of the Workers' (Communist) Party of America) its editors and authors of obscene printed matter criticizing America, resulting in a conviction by the State and a Federal indictment against the same defendants which has not as yet come to trial. (31) Through the medium of the Surgeon General tendered services to the American Red Cross of former medical officers to assist in the relief work in the Florida disaster and the Mississippi Flood district. (32) Disclosing, through the medium of the Chaplain General, the inaccuracy and inadequacy of many of our school histories in connection with the part American troops played in the World War.

Its National Bulletin

The National Bulletin, official publication of the Order, is issued monthly. Its first number was printed in 1921 and it has grown from a four-page folder to a publication ranging in size from eight to twenty pages. It is the only vehicle by which the activities of National Headquarters and the various chapters are transmitted to the general membership.

Not only does the National Bulletin publish the general news of the Order but it covers varied and vital subjects of information relative to National Defense, Officers, Reserve Corps, Citizens' Military Training Camps, Reserve Officers' Training Corps, National Guard, etc., but disseminates information on radical, pacifistic and non-resistance activities that have for their objectives the undermining of our national security and the disintegration of our American ideals and principles. This particular kind of information is published for the sole purpose of furnishing chapters and individual members of the Order with reliable and authentic data on subversive activities.

The Importance of Explosives Manufacture

An excerpt from "Explosives, Powders and Combat Gases," by Paul Pascal, Paris: Libraire Scientifique—J. Herman. 1925. Excerpt translated by Maj. Aiken Simons, C. A. C. Res.

IN time of peace mines consume the greater part of explosives; black powder for quarry work, black powder dynamite and chlorate mitxures for work in galleries which do not develop fire damp; safety explosives where fire damp is to be feared.

Before the outbreak of the War, the French General Staff, basing their estimate on data from the War of 1870, foresaw a daily expenditure of 24 tons of smokeless powder. Our powder mills were capable of making only 22.5 tons, but there was on hand a stock of 720 tons of guncotton, an equivalent stock of nitrated derivatives and it was estimated that this would do for ten months, during which time it would be possible to improvise new plants or arrange for importation. The powder factories had in their reserve storehouses sufficient cotton for five months, alcohol and ether for two months, acids and nitrate for six weeks.

It is well known how events turned out at the outbreak of the War, causing concern as to the modesty of these provisions, how the pursuit of the routed German Army after the Marne was held up for lack of munitions and how (just before the final victory) it was necessary to depend on the powders salvaged from the wreck of the "Iena" in the Port of Toulon.

The progress of the program laid out for the artillery and almost entirely realized, corresponded to the following daily consumption for France alone expressed in tons:

	Powder Demand	Powder Expenditure	Chlorate Explosives	Nitrate Explosives
Plan of mobilization	24	22.5	0	0
January 1915	90	60	15	160
July 1915	190	115	50	410
October 1915	310	160	80	650
March 1916	350	240	190	550
August 1916	510	395	200	700
January 1917	550	375	190	940
July 1917	640	460	125	940

In order to realize this colossal effort of production it was necessary to develop at first the existing powder mills and to supplement them by certain private factories:

Celluloid factories which prepared the crude nitrocellulose.

Paper mills, which having a source of pure water, were able to purify the guncotton.

It was then necessary to create new powder mills planned on a much larger scale than the older ones: At Toulouse in 1915, at Bergerac in 1916, at the same time plants were developed for the manufacture of powder B.

But it was further necessary to import from abroad, especially from the United States and the more so, because the risk of torpedoes rendered more interesting the purchase of finished products. In the case of powder, ship tonnage was thus reduced in the ratio of 12 to 1.

So far as high explosives were concerned, we had to evacuate the powder mill at Esquerdes near Saint Omer, at the time of the German drive to the sea and reinstall this machinery in the plants in the southwest. The loss of our coking plants in the north aggravated still further our lack of hydrocarbons; it was necessary, therefore, to import benzols and extract the benzene ring compounds from Borneo petroleum. Our black powder plants were arranged for the manufacture of Schneiderite and new plants were everywhere constructed which lent their support to the considerable importations of Melinite from the United States along with the arrival of nitrate of ammonia from Norway. This, to a great extent, was the cause of the plants which we had to build for the manufacture of synthetic nitric acid at Angouleme, Bassens and Sorgues, etc.

In the domain of explosives the chemical effort was the most important. It was necessary to put into practice new or better methods; the manufacture of synthetic phenol grew from 600 k.g. to 370,000 k.g. per day, and we were tributary to foreign countries for only a small portion of this product.

The efforts of the French factories, assisted by the seized German dye works, permitted us to supply our most urgent needs. Toulouse was able to furnish even Italy, when she came into the War. We had to take care of the belligerents of the Balkans throughout the entire war, and the Americans supplied themselves from us in 1917 and 1918.

We had at the time of our greatest effort in 1917—120,000 working men and working women in our munition plants, of whom 60,000 were engaged in constructing new plants.

As a total 1,200,000 tons of explosives and 300,000 tons of B powder were manufactured in France, reducing in this way the importations. The daily maximum production in 1917 reached the following values:

Guncotton	Made	433 Tons
	Imported	60 Tons
Powder B	Made	503 Tons
	Imported	200 Tons
Nitrated Explosives Total		730 Tons
Chlorate Explosives Total		170 Tons
Panclastite Total		60 Tons

It is necesary to note in passing the corresponding enormous expense of acids which reached the maximum of 2,800 tons of sulphuric acid, 600 tons of oleum, and we would have needed 1,500 tons of Chili saltpetre had not the manufacture of synthetic nitric acid partially solved the question of tonnage.

Ordnance News in Pictures

Japanese Landing Forces, equipped with rifles and field pieces, marching toward Tsingtao, China.

U. S. Marines, with Browning machine gun and Springfields, guarding the American Legation at Peking, China.

One of the Coast Defense guns at Fort Hancock, New York, being fired during recent target practice exercises. Major Pinger, in his article, describes many of the problems encountered in keeping weapons of this kind in good order and repair.

The Maintenance of Armament

Part II

Maj. R. W. Pinger, Ord. Dept., U. S. A.*

RETURNING again to the specific problem of maintenance it may be well to consider some of the problems for which climate is accountable, especially the conditions of temperature and humidity. These might be listed from a commodity standpoint, as follows: (a) paint, (b) oils, (c) packings, (d) insulating materials, (e) optical equipment.

The writer feels that the man who invented the slogan "save the surface and save all" must have been an armament officer, for nowhere more than in his work, is the statement less an exaggeration. In civil life open-air substations are common, but most machines as complicated as a gun are carefully roofed and walled in for protection against the elements. Naval turrets are warm and dry and even army field guns are placed in gun sheds except in war time. But fixed harbor artillery is subject to wind, rain, fog, ice, salt and sand. In these days of aircraft reconnaissance, even the parapet which used to give a little shelter, is being discarded. So the problem of protecting finished steel surfaces is a most difficult one.

Realizing the importance of the problem, the Ordnance Department some years ago conducted a long series of tests using preservative paints and oils under many different climatic conditions. As a result, specifications for these articles for tropical use were worked out, as well as for the conditions in different parts of the United States. Each formula was made as nearly commercial as possible and no unnecessary formulae included to complicate procurement. When the World War came along, much reorganization took place especially in the direction of concentration of procurement responsibility. For example, the Ordnance Department was required to procure all machine tools required by the entire Army; however its precious paint and oil procuring prerogatives were ruthlessly torn from it and handed over to another supply department. Imagine the consternation when ordnance officers saw their wonderful rust-resisting paints beautifying rough wooden storehouses, while cheap household paint of the ordinary sort was the only article available for the guns.

At one battery there was much complaint about the sponging compound used in cleaning the bores of heavy guns after firing. Investigation by the writer developed the fact that cutting compound (used in machining steel)

*In charge of Ordnance Unit, R. O. T. C., University of California. Formerly Assistant Department Ordnance Officer, Philippine Department.

had been issued in place of the proper substance. Evidently the supply officer considered that "compound was compound."

This same changing in responsibility was felt in the matter of recoil oils. Adoption of foreign types of guns without redesign of recoil and recuperator mechanisms naturally made many foreign oil specifications the only safe ones to use. In other words, it was simpler to procure oils of special viscosities than it was to recompute and reproduce a lot of new carriage parts. However the new procurers of recoil oils had no sympathy for this viewpoint and only after the greatest reluctance proceeded to get what was needed. Since the war, much has been done to return to the Ordnance Department the procurement of all special materials of this kind required for the successful operation of matériel supplied by it.

A great deal of apparatus for use in exposed damp positions seems to be designed with the idea of keeping moisture permanently out of a mechanism. For example, the retraction motors on most disappearing carriages are of the completely enclosed type with elaborate cover-plates, rubber gaskets, etc. However, the heat of the tropical day causes an expansion and expulsion of the entrapped air. When night comes the reverse occurs and cool damp air is sucked back into the apparatus. Moisture condenses and trickles to the bottom of the casing, there to accumulate until brushes and commutator are practically submerged. The remedy fortunately is simple—a few minutes' work with an electric drill provides a drain hole in the bottom of the casing and renders gaskets forever useless.

The question of insulating materials presents no such ease of solution. During the three dry months little difficulty is experienced but as soon as the typhoons appear, electrical apparatus of all kinds seems to become quite saturated with moisture. No visible condensate may be present but every part seems to be partially grounded, especially the frames of small motors only occasionally used. Practically the only way of avoiding serious damage is to run such motors frequently and regularly until well dried out. In these days of economy this is not always practicable.

But serious as the effect of climate may be on these commodities, they are as nothing compared with the havoc played with optical equipment. To one unfamiliar with range-finding and fire-control equipment, it is quite surprising to see how formidable a list of optical instruments is required by a modern seacoast battery. Such a list might be as follows: (a) depression position finder at primary station with azimuth instrument in reserve; (b) same at secondary station; (c) same at auxiliary station if in use; (d) battery commander's telescope at B. C. station; (e) self-contained short-base range finder at emergency station; (f) telescopic sight on each gun with at least one in reserve for each battery; (g) half a dozen or more pairs of prismatic field glasses, and several spare azimuth instruments for use by spotters, deviation observers, etc.

When Galilean instruments with few, if any, compound lenses were used, cleaning and drying of surfaces was not difficult and endangered little beside the cross hairs. In these days, however, the demand for brilliant illumination, flatness of field, sharp definition at edge of image, has led to an almost universal use of very complex prismatic instruments. In these the various prisms are permanently adjusted, set and sealed against moisture. It is not expected that they will ever be disassembled except at the factory or arsenal specializing on such work.

As in the case of the enclosed motors, however, moisture *does* leak in after nine months or a year and before long one can see far more with his naked eye than through an instrument. To make matters worse, the difficulty is not confined to the exterior surfaces of the lenses. A compound lens or prism is composed of two or more pieces of optically differing glass cemented together with Canada Balsam. The latter ebing organic soon falls prey to the insidious tropical atmosphere and when one looks through his glass in reverse, he sees the most beautiful frost-like tracery. At first there may be but a spot but day by day it grows until the whole field is occupied. To "break" and rejoin the prisms in the Philippines is of course mechanically possible but as new organisms, if such they are, would be sure to get in during the operation, it would be futile.

Accuracy Life of a Gun

From the layman's point of view perhaps the best known factor in armament maintenance is that which has to do with the accuracy life of heavy artillery. The public was not surprised to learn that the famous German long range gun needed reboring or relining after each fifty rounds. It would probably be more surprised to learn that the formulae now used in computing accuracy life are but the roughest approximations, and that there are all kinds of factors which must be considered in order to arrive at accurate figures for any particular gun. For example, it used to be considered that a 14-inch gun using a muzzle velocity of 2,350 feet per second would last 150 rounds whereas dropping the velocity to 2,250 would double the life. However it has been discovered that other factors, such as the shape and width of the rotating band on the projectile, have effects of the same order. It is therefore a most fascinating problem in armament maintenance to attempt to measure these factors as time goes on with a view to establishing more accurately the coefficients involved.

To do this a little special equipment is needed: (a) the original arsenal star-gage record showing the exact diameters of bore between lands and between grooves at each inch of length; (b) a star-gage outfit and operator with the proper "feel"; (c) an authentic log of every shot fired in the past.

Early in his tour in the Islands the writer embarked on an experiment of this kind with the highest hopes. When the measurements of a particularly old gun were made and duly plotted to a greatly magnified radial scale, he was amazed to find that in many parts of the bore the diameter was actually less than when the gun first left the rifling machine! Of course the answer was that the pressure of the projectiles' rotating bands had plated the rifling, both lands and grooves, with copper, completely obliterating the erosive effect the measurement of which was desired. So back to the States went a requisition for a newly-devised

copper-removing tool, and out to the troops went a resurrected order concerning the use of anti-copper-fouling foil when firing. Before the tool arrived, or the alloying effect of the foil in future firings could be verified, the writer's successor had arrived.

Of course the loss of accuracy can theoretically be computed from past target practice records. The analysis which invariably follows such practice always separates errors of personnel from those of matériel. But as the latter include those of the powder and projectile as well as those of the gun, solution is practically impossible. In computing the probable frequency of relining of guns in war time it is therefore necessary to fall back upon empirical formulae, of which a good example is the following:

$$L = \frac{2{,}500 \times P\,1.7}{V^2 \times D \times (D-2)}$$

where L = Total rounds
P = Chamber pressure in tons of 2,240 pounds per square inch
D = Caliber in inches
V = Muzzle velocity in thousands of feet per second

Substituting the appropriate values in the case of the 14-inch guns mentioned above we get—

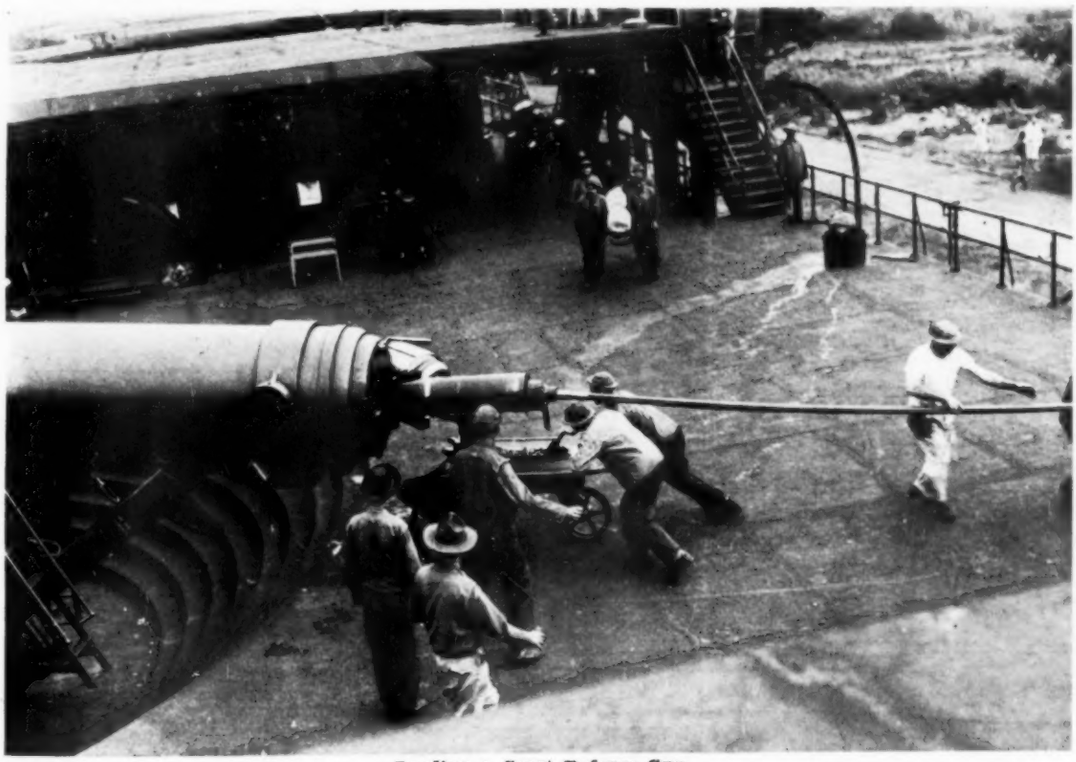
$$L = \frac{2{,}500 \times \frac{(38{,}000)\ 1.7}{(2{,}240)}}{(2.350)^2 \times 14 \times 12} = 331$$

This formula is intended for use only with large caliber guns and obviously gives a result of twice the magnitude of the assumption referred to. When the lower velocity (2,250 feet per second) is substituted, the life increases to 361 rounds which is far from twice its former value.

The Cost of Armament Maintenance

A noted engineer upon being requested to define his profession stated, "An engineer is a man who for one dollar can do what any ordinary fool can do for two." If this is true there can be no more important phase of armament maintenance than its cost in dollars and cents. In general this element may be subdivided as follows:

(a) Direct labor, including
  (1) Civilian labor directly chargeable to the work;
  (2) Enlisted and commissioned labor directly applied but not charged to the work.



Loading a Coast Defense Gun.

(b) Direct material, including
  (1) Material specially purchased and charged to the work;
  (2) Material obtained by requisition without reimbursement from funds allotted to the work.

(c) Overhead, including
  (1) Indirect civilian labor employed in supervisory, clerical or general capacities, and prorated against the various work orders. This item also includes pay for holidays, vacations and so on for both direct and indirect civilian labor;
  (2) Enlisted and commissioned labor of a similar nature but not charged to the work;
  (3) Indirect material such as oxygen and acetylene and other general shop supplies, exact charges for which cannot be accurately made without excessive bookkeeping;
  (4) Power, transportation and similar items for which payment must be made;
  (5) Similar items not charged to work directly or through the medium of overhead.

There is no doubt that a completely centralized organization could obtain entirely accurate figures on all the above items of cost. In fact among certain governmental institutions there is quite a tendency to accomplish just such a result. However an organization having activities scattered all over the globe and the essential aim of which is to insure national security rather than lowest possible cost, cannot be expected to have such a policy. The World War demonstrated many things, but none more conclusively than the danger of destroying initiative and lessening of the sense of responsibility by the undue concentration of control at Washington. It must be admitted, however, that the doctrine of decentralization as now taught and practiced, leaves much to the imagination when one desires to assemble cost data. Men charged with the immediate spending of money usually hire more machinists and less bookkeepers. They keep such costs as will insure the efficiency of their own work, and care little for those beyond their control even where from an accounting standpoint the latter are as important as the former.

The result is that at present but few of the subdivisions mentioned above can be accurately determined. For example, item a-2 is ordinarily changed to the appropriation "Pay of the Army" and not to the specific work on which engaged at all. Without an elaborate time-keeping system accurate virtual costs are of course impossible. The same is obviously true of item e-2.

When it comes to item b-2 there could be vast improvement without great change in existing administrative methods. For example, if Watertown Arsenal manufactures a number of special parts for increasing the elevation of 14-inch guns, there is no reason why the production cost of these parts should not be typed on the invoice which transfers them to the Philippine Islands. Similarly the value of the transportation involved (probably by Army transport) ought to offer no difficulties in computation even though the Armament Officer is not called upon to defray it. However the present policy encourages an officer to watch his own costs and to concern himself but little with those of others. Even at his own post of duty he may not have as much control as he would like. Appropriations are usually made on estimates of considerable antiquity; some activities are thus well provided for while others of equal importance are all but starved. No sane officer would think of juggling appropriations; however few hesitate to shift the overhead burden a little one way or the other to help the less pecunious activities. Cost accuracy is thus impaired by just that amount.

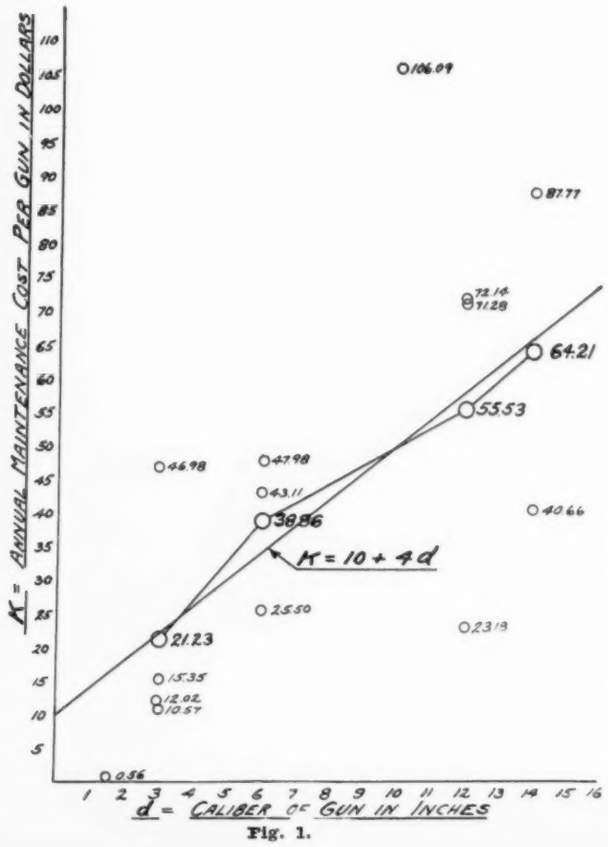


Fig. 1.

Cost Control Data

With some of these difficulties in mind, the writer will describe an attempt he made to obtain data on costs controlled by him during the fiscal year 1923-4. These costs are for repair only and are given per unit (gun and carriage) rather than in total. They include items a-1, b-1, c-1 and c-3 above.

	Direct Labor	Direct Material	Overhead	Total
37-mm. field gun	$ 0.38	.....	$ 0.18	$ 0.56
2.95-inch mountain gun	28.25	.....	18.73	46.98
75-mm. field gun	7.41	$0.05	4.56	12.02
3-inch A. A. gun	8.82	.....	6.53	15.35
3-inch seacoast gun	6.26	.....	4.29	10.57
155-mm. field gun	26.64	.....	21.34	47.98
6-inch seacoast gun, barbette	14.44	.....	11.06	25.50
6-inch seacoast gun, disappearing	29.38	.....	13.73	43.11
10-inch seacoast gun, disappearing	64.22	.....	41.87	106.09
12-inch mortar	13.99	.....	9.19	23.18
12-inch gun, disappearing	43.41	.....	28.73	72.14
12-inch gun, barbette	39.28	5.51	26.49	71.28
14-inch gun, disappearing	22.73	1.00	16.93	40.66
14-inch gun, turret	49.73	.....	38.04	87.77

These figures do not include work on optical and fire-control instruments pertaining to the above. To prorate this would require the following additional charges.

	Direct Labor	Direct Material	Overhead	Total
Percentage	25.1	0	22.8	24.13

If the total column in above tabulation be plotted as a function of caliber, some interesting results are obtained (see Fig. 1). It is obvious that the 37-mm. and the 10-inch guns are of little assistance in determining the curve and the law which it represents. The explanation in the one case is that the 37-mm. guns were used only to a very limited extent during the period under consideration. Being small and portable they were stored indoors as in the case of machine guns. Minor breakages were rectified by the replacement rather than by the repair of parts. In the case of the 10-inch guns circumstances were quite different. These were very old guns, antedating the 12-inch and 14-inch by many years. Their carriages were made when cast steel was still something of a novelty and when little

was known about annealing and heat-treating processes which now make cast steel most dependable. The annual repair cost of $106.09 per gun therefore covers the repair of an actual breakage of one crosshead rack and of at least one elevating arm. It also defrays several time-consuming sets of bore star-gaging measurements undertaken as two guns approached the supposed limit of their accuracy life.

Eliminating consideration of these two weapons a numerical average may be computed for each group of almost equal caliber. This gives the following figures:

Caliber	Cost
3-inch	$21.23
6-inch	38.86
12-inch	55.53
14-inch	64.21

It may be suggested that the mean cost of all guns in a caliber group should be computed rather than the average of the mean costs of each type within a group. In other words if

M = number of 12-inch mortars
D = number of 12-inch disappearing guns
B = number of 12-inch barbette guns

the cost desired would be—

$$C = \frac{23.28\,M + 72.14\,D + 71.28\,B}{M + D + B}$$

It happens that M greatly exceeds either D or B. If this equation is used C will be more than $23.18 but much less than $55.53. However what is desired if possible is a general expression which can be used with any ratio of M to D or B rather than with the one existing in this particular case. Any one knows that a 12-inch mortar is a far less complicated mechanism than a gun of the same caliber. We must therefore choose between disregarding it as a 12-inch weapon entirely, or averaging its unit maintenance cost with the others on a basis independent of M.

A straight line may be drawn as nearly through the four points above mentioned as possible, and the following law deduced—

$$K = 10 + 4\,d$$

where K = the annual repair cost per gun in dollars and d = the caliber of gun in inches. Substituting numerical values and solving for K we obtain—

Caliber	Cost
3-inch	$22.00
6-inch	34.00
10-inch	50.00
12-inch	58.00
14-inch	66.00

To these values should be added 24.1 per cent. or say one-fourth, to include the maintenance of pertaining fire-control equipment.

It is probable that this equation has as much accuracy as that involving the accuracy life of guns mentioned above. It would be interesting to investigate its relation to the first cost of the armament concerned. Unfortunately, however, data of the latter nature vary widely in date and circumstances of procurement. It is rather hopeless to compare the production costs of an arsenal-built weapon of 1901 with a civilian fabrication of 1918. It would also be useful to evaluate in some way the costs represented by items a-2, b-2, c-2, c-4 and c-5. The writer cannot help but believe that in general they could be applied as direct factors (as in the case of the fire-control equipment) with little loss of accuracy. Should he ever be in an official position permitting him to secure the necessary facts, he will surely verify his belief.

Propellants

At the start the writer indicated that his purpose was to cover that part of the armament field including the projectile and the essential instrumentalities for its discharge and control. Strictly speaking he should now discourse briefly, at least, on prepellants, or what the public commonly calls powder. As this is really a chemical rather than a mechanical matter, he will content himself merely with a statement of the problem and of the local measures taken by an armament officer for its control.

The propellant universally used in U. S. Army guns is a colloided nitrate of cellulose, commonly called N. C. smokeless powder. It is much less erosive than nitroglycerin or cordite powders but has the very serious defect of being highly hygroscopic. The absorption of moisture accelerates decomposition and materially affects the ballistic qualities of the powder. The maintenance problem has therefore three phases: (a) preventing ingress of moisture; (b) verifying the degree of chemical decomposition; (c) verifying the degree of ballistic deterioration.

Guns below 4.7-inch in caliber ordinarily use fixed ammunition in which the propellant is contained in a brass case. It is not difficult to seal the primer in the base; at the other end a thin brass diaphragm soldered in with bismuth solder of low melting point effectively guards the powder independent of the fit of the projectile. The writer remembers one instance at Corregidor where several hundred rounds of ammunition of this character were immersed in floodwater for nearly a week without the powder being affected in the least. The "hermetically sealed" zinc-lined packing boxes were however with few exceptions, filled with water.

Larger guns are separate loading and their powder is contained in raw silk bags encased in heavy steel cartridge storage cases. Various means have been tried for sealing these cases—solder, rubber gaskets, paraffin and so on. None seems proof against transportation shocks. The only practicable plan seems to be to store them permanently in such a manner as to expose one end of each case and to test each periodically by means of a vacuum pump and mercury manometer. The slightest leak will induce the pumping action described above although not of course to the same extent.

For observing the degree of chemical decomposition each magazine contains bottles of each powder stored therein, in which a strip of methyl violet paper is suspended. Decomposition is always accompanied by the liberation of free acid which whitens the paper at certain well known rates. When a certain rate (in days) is reached the powder is segregated from its neighbors; still later, destruction may be necessary. At Manila the Armament Officer also has

electric surveillance ovens maintained at a constant temperature of 65.5° C. Failure of powder under these circumstances is comparatively abrupt and is accompanied by a visible emission of nitrous oxide. As before, the number of days required for decomposition is an index of stability. By plotting this index as a function of days a curve is obtained from which the probable life of the powder may be predicted with fair accuracy.

In this connection two interesting phenomena were observed by the writer in the Philippines. In one case methyl violet paper which had whitened in proximity with powder seemed to regain its color during transit by mail. In many other cases powder which in the United States gave 65.5° tests of from four to five hundred days failed in less than sixty at Corregidor. Even where tropical temperature and humidity conditions were duplicated in special surveillance chambers, there seemed to be a great discrepancy between results obtained in New Jersey and those in Manila. It has been suggested that differences in the non-visible portions of the solar spectrum in the two regions may have an influence on the matter. The investigation of this and other phenomena such as the corrosion of aluminum fuze seat liners in the presence of ammonium picrate (high explosive), or that of cast iron grenades in the presence of ammonium nitrate, would be an interesting field for the physical chemist.

The degree of ballistic deterioration may ordinarily be obtained from target practice reports which record (for separate loading weapons) powder chamber pressures and apparent muzzle velocities. However the former are usually questionable as they represent merely a cumulation of successive pressures in a rapid series of shots. Likewise the apparent muzzle velocities are of doubtful value as they are computed from attained ranges and thus include any error due to inaccuracy in application of meteorological data. The Artillery will frequently lay undeserved blame on a powder merely because it is old, and the only way to reestablish confidence is to erect towers and screens and to actually measure the muzzle velocity by means of the chronograph. At the same time pressures for each shot may be taken with copper crusher-gage cylinders of undoubted reliability and any fears for the safety of the gun allayed. As the safety factor of the latter may be but 1.3 this is of the highest importance.

There are many other tempting phases of armament maintenance but unfortunately nearly all of them develop into problems outside the province of the mechanical engineer. This does not usually prevent the latter from discovering the initial data upon which further investigations are based. However the purpose of this paper will be better served by summarizing the factors already developed rather than by discussing others of secondary importance. The important ones are as follows:

(a) That in the prevention of obsolescence (alteration of armament) accurate and comprehensive records are as indispensable as is engineering ability.

(b) That in the prevention of deterioration (repair of armament) status, location and climatic conditions play a very important part.

(c) That in both cases the personnel problem is of greatest import, especially in places as remote as the Philippine Islands.

(d) That in repair it is possible to reduce certain important elements of annual cost to an empirical law in terms of caliber.

(e) That in the maintenance of chemical components (propellants and explosives) many problems remain to be solved by the chemist.

Antiaircraft Equipment Establishes Record

IN the annual War Department efficiency tests of the searchlights and sound locators of Battery "A," 63rd Coast Artillery (Antiaircraft) recently conducted near Palo Alto, Calif., the battery scored a remarkable record of 100 per cent. hits.

The purpose of the exercise was to test the efficiency of sound locators and searchlights in discovering and illuminating bombing planes passing over a defended area. It was in no sense a contest between the Air Corps and ground forces, between which the closest cooperation and understanding prevailed throughout all preliminary training as well as during the record tests. There resulted much accurate information of value to both the Air Corps and the Artillery.

An observation plane from Crissy Field carried out the simulated attack by bombing planes on an objective located near Los Altos. The battery organized a defensive zone over which the plane was to pass, in an area south of Stanford University, and by means of sound locators and searchlights, discovered and illuminated the plane as it flew over.

The plane, without running lights, made four simulated attacks on each of two nights at intervals of from 10 to 20 minutes. Under the conditions of the problem, on each passage through the defended area, the plane simulated dropping of a bomb by firing a white rocket at the time and under conditions the bomb would have been released in a real attack.

The defensive zone was about two and one-half miles wide and the plane was free to fly within the limits of the zone at any desired altitude above 2,000 feet, and to maneuver under service bombing conditions as desired by the pilot. The average altitude for the four flights on the first night was 8,500 feet and on the second night 8,000 feet.

So efficient were the listening devices and searchlights that on every passage of the plane it was discovered and illuminated for approximately two minutes before the bomb release signal was fired. Under service conditions the plane would have been sufficiently illuminated to permit effective fire from antiaircraft guns and machine guns before it could have reached its objective.

The consistency of detection is shown by the fact that during the last four nights of preliminary training and the two nights of record tests, the plane made 34 attempts to pass unnoticed over the defended area but was discovered and illuminated on every passage except one.

Editorial

Our Ninth Annual Meeting

WITH the approach of early fall comes the "Aberdeen urge," which is another way of saying that one of those monster meetings of the Army Ordnance Association will be held shortly at the Aberdeen Proving Ground. The Ninth Annual Meeting of the Association will take place at Aberdeen, Thursday, October 6, 1927. As in the past, the meeting has the hearty approval of Hon. Dwight F. Davis, Secretary of War, who has authorized the use of the Proving Ground on that date for the purpose. In addition, Maj. Gen. C. C. Williams, Chief of Ordnance, and Lt. Col. C. M. Wesson, Commanding Officer of Aberdeen Proving Ground, are lending every effort to make the ordnance demonstrations and exhibits on that day of unusual interest to all who attend. Chiefs of the several branches of the Army are also cooperating splendidly so that there is every indication that the coming meeting will be the most elaborate of them all.

By invitation of the Board of Directors of the Army Ordnance Association several nation-wide organizations have been invited to participate in the meeting. This is in accordance with custom established some years ago. This year the participating organizations will be the Society of Automotive Engineers, the American Society for Testing Materials and the Military Order of the World War. Each of these societies has a very pertinent connection with ordnance.

Of the Society of Automotive Engineers it can be said that it has always cooperated to the fullest extent in the development of automotive ordnance. Few, if any, of the unusual automotive designs peculiar to the military service have been adopted by the Army without the advice of the scientific talent of the engineering committee of the S. A. E. involved. Indeed that Society estimates the importance of automotive design and development as applied to things military to such a degree that one of its principal groups is its Ordnance Advisory Committee composed of engineers whose record both in the field of commercial as well as military automotive engineering is of the highest order. That the Society of Automotive Engineers should participate in an Aberdeen meeting is, therefore, in accordance with the best interests of military and commercial automotive development. Our engineers who are incessantly occupied with the changing designs of commercial vehicles will do well to spend a day at Aberdeen and refresh their minds on some peculiarities of automotive engineering with which they are not brought into daily contact. The class of military vehicles discussed by Maj. A. B. Quinton in this issue of ARMY ORDNANCE suggests at once their unusual characteristics and it is readily apparent that ordnance automotive requirements are separate and distinct to a great degree from those of everyday commercial demand.

Because of the wise policy of the Chief of Ordnance this last statement is subject to qualification in that he has endeavored to standardize for Army use commercial vehicles wherever possible, particularly in the field of tractor and cross-country car requirements. From the nature of the case, however, it seems that there must always be military vehicles which will never have their exact counterpart in commercial industry, and therefore it is to be hoped that the present close contact and cooperation between our commercial and military automotive engineers will continue.

Likewise it can be said that the American Society for Testing Materials occupies a unique position in the realm of national defense. Possibly no other element of our Government has quite the same degree of dependence on the testing and standardization of materials as has the Ordnance Department. After all, the complex items of ordnance must be composed of myriads of components all of which are intensively tested and standardized. The Watertown Arsenal Testing Laboratory, long a prime factor in this field, has, as Colonel Dickson in his article in this issue of ARMY ORDNANCE points out, won for itself an enviable reputation. The laboratories at other ordnance arsenals are also doing excellent work in the testing of materials. The results of their investigations are freely interchanged with similar organizations in industry and it is through the medium of an organization such as the American Society for Testing Materials that these bonds of contact are sustained and brought closer.

The Military Order of the World War can not be classed as an engineering society at all. On the contrary, it is a body of former officers of the Services who served during the World War similar to the Order of the Cincinnati of the Revolution and the Loyal Legion of the Civil War. Its interest in matters of national defense is solely patriotic. That this Order should combine with us at Aberdeen is readily apparent. It is hoped that the members of the M. O. W. W., who will be in convention in Baltimore for one day preceding the Aberdeen meeting, will find in the program of demonstrations on October 6th a stimulus for their worth while endeavors and an assurance that ordnance—"the crux of our national defense"—has kept apace with the remarkable mechanical developments of the age.

This year the meals will be prepared and served by personnel of the Quartermaster Corps of the Army. Through the hearty cooperation of Maj. Gen. B. Frank Cheatham, The Quartermaster General, Army food in Army style will be served by the School for Bakers and Cooks from Camp Meade, Md. This organization has already won a reputation for itself by handling such functions, and the character of cooperation given by the Quartermaster General and his staff is ample warranty that this feature of the meeting will be a pleasing and highly satisfactory innovation.

"A Defense-Minded Public"

HON. F. TRUBEE DAVISON, Assistant Secretary of War, in a recent address, sounded a very novel note when he said, "With our limited military establishments it is essential that this country have a defense-minded public; a public in hearty sympathy with and through understanding of the Government's aims and purposes along military lines."

There is food for much thought in this statement by Mr. Davison. Obviously it would be impossible to gage the exact degree of defense-mindedness of the American people. Such a condition, in the aggregate, is one of those things that has to be felt rather than determined by slide-rule or statistics. It must be sensed rather than calculated. That every American has the requisite patriotism which demands an adequately protected country goes without saying, but we do not interpret defense-mindedness to mean only that. There is more of the element of action in the term. We therefore are forced to the conclusion that America has not enough of its people actively interested in national defense. And since the state of mind is a prerequisite of action, we too see, with the Assistant Secretary, the need for a greater public interest, sympathy and understanding of the Government's aims and purposes along military lines.

Judge Gary

THE death in New York, August 15, 1927, of Judge Elbert H. Gary, Chairman of the United States Steel Corp., member of the Army Ordnance Association, and Chairman of the Advisory Board of the New York Ordnance District, marked the passing of an industrial leader whose interest in munitions preparedness was on a par with his outstanding ability in American industry. It is just three years ago that Judge Gary, with other members of the American Iron and Steel Institute, attended in a body an annual meeting of the Army Ordnance Association at Aberdeen Proving Ground. On that occasion this interest of the great industrial leader took the form of a pledge when he spoke on behalf of the steel industry of America and its obligations to the national defense. At that time Judge Gary said:

"And may I add, though perhaps it may seem unnecessary, should in the future our beloved country again be thrust into the necessity for national defense, that the iron and steel industry will again promptly and with vigor meet the situation to the utmost of its ability. We have in the United States a total capacity for steel production greater than that of any other country, greater, indeed, than the combined capacities of all the other countries, and I wish you gentlemen of the Army to know that in your studies of preparedness for national safety that the iron and steel men are behind you with their sympathies, abilities and resources. I congratulate you again, General Williams, and your associates, and you gentlemen of the Army Ordnance Association, on the great and valuable work you are engaged in, as so interestingly and capably displayed here today."

The loss of a man of Judge Gary's attainments is real. It is consoling to know, however, that his concern for ordnance affairs characterizes the executives and workers of practically the entire iron and steel industry of the country.

Maj. Gen. Charles P. Summerall, Chief of Staff and Acting Secretary of War, voiced the sentiments not only of the Army but of all friends of munitions preparedness in the following letter of condolence which he wrote to the officials of the United States Steel Corporation:

"In the great loss that has come to the United States Steel Corporation in the death of the Chairman of its Board of Directors, Judge Elbert H. Gary, I desire to express the sympathy of the War Department.

"Through his long career Judge Gary was of distinct service in the cause of national defense. During the World War under his chairmanship, the Central Iron and Steel Committee of the War Industries Board rendered invaluable service in assuring adequate supplies of iron and steel required in the munitions program. With the loyal backing of the United States Steel Corporation, through Judge Gary's efforts, the enormous demands for iron and steel were met.

"With the coming of peace, his patriotic ardor never cooled. As a member of the Advisory Board of the New York Ordnance Procurement District, as a member of the War Department Business Council, and as an Honorary Adviser of the Army Industrial College, he gave of his time and strength in furthering industrial mobilization. From his long experience as a leader in the industrial world he was keenly alive to the necessity of planning in time of peace. It was with unfailing loyalty that he gave his support to our endeavors in that direction.

"In Judge Gary's death, the War Department loses a most valuable and inspiring adviser."

The New Chief of Field Service

AS announced elsewhere in this issue of ARMY ORDNANCE, Col. Samuel Hof has been appointed a Brigadier General and Assistant to the Chief of Ordnance in charge of Field Service of the Ordnance Department. General Hof succeeds Brig. Gen. John W. Joyes, whose excellent work as Chief of Field Service for the past four years is well known to members of the Army Ordnance Association.

The Field Service, or supply and maintenance phase of Ordnance responsibility, is one which may often appear to be secondary to that of the design and manufacture of munitions. This may be so from the very nature of the case. There seems to be a greater fascination in the development of a new weapon or in a new process for manufacturing an old weapon than there is in the seemingly routine functions of supply and maintenance. If such a belief is at all general it is all the more erroneous. The essence of defense is readiness—the ability to concentrate power where needed. We may have the best designed weapons in the world but unless they are at hand when and where required they are of no earthly good. Therefore to have available for its "customers"—the using services of the Army—weapons in kind, quality, and state of preservation necessary to accomplish a given military mission, is the essence of munitions preparedness and this is the function of the Ordnance Field Service.

We congratulate General Hof and wish for him the high degree of success in this important assignment which characterized the efforts of his predecessor.

Professional

The Function of Caps on Armor-Piercing Projectiles

IT IS not the intention of the writer to attempt to present anything new as the subject is largely historical. The selection of this topic is due to the interest shown by Reserve Officers taking the basic course at Aberdeen and it was thought the information would be appreciated by them.

The theory outlined is largely from personal notes of the writer. More complicated theories are available but there is considerable doubt as to the accuracy of any of them when practical results are considered.

The cap is a most important part of the armor-piercing projectile. It is so important in fact, that it is absolutely essential to the armor-piercing function of the shell. No matter how fine the quality of the projectile, it is helpless without the aid furnished by its cap, particularly when tested against plates of equal caliber.

The development of cap design has been influenced largely by changes of ogive contour in the interest of increased flight. The first type of cap used was a small cylindrical button-like knob on the extreme point of the shell similar to that shown in Fig. 1.

This was modified for greatly improved piercing qualities to a much heavier cap with bearing considerably further back on the ogive and larger in diameter which afforded a wide area of cap at point of impact (Fig. 2). A soft Bessemer steel was the approved material for this cap. A long series of successful tests resulted from its use.

Next came the discovery of greatly increased flight with an ogive of long radius. This was such an important factor that the change was inaugurated in the Navy almost immediately and resulted temporarily in a great diminution of armor-piercing qualities.

A long series of experiments became necessary to study both cap design and material in an endeavor to improve armor-piercing quality and still maintain the contour required for flight. Before definite conclusions had been reached, a partial relief was afforded by the use of a new nickel-chromium composition for the projectile itself.

Among the caps tried were: solid cap (Fig. 3.). Materials tried: (a) soft steel, (b) copper. Button cap (Fig. 4) similar to old design but covered with a thin copper windshield. Two piece cap (Fig. 5) with a hollow tip. Materials tried: The cap proper of soft steel; experimental tips of (a) cast iron, (b) .40/.50 carbon steel, (c) soft steel .05 carbon.

The experiment illustrated in Fig. 3 was a failure when steel was used, but was successful with copper. Several trials however showed this design to be erratic.

Caps made as in Fig. 4 were fairly successful but were not given serious consideration because of the difficulty of handling without injury to the copper windshield.

The type shown in Fig. 5 seemed most practical and, as indicated above, the study became one of material suitable

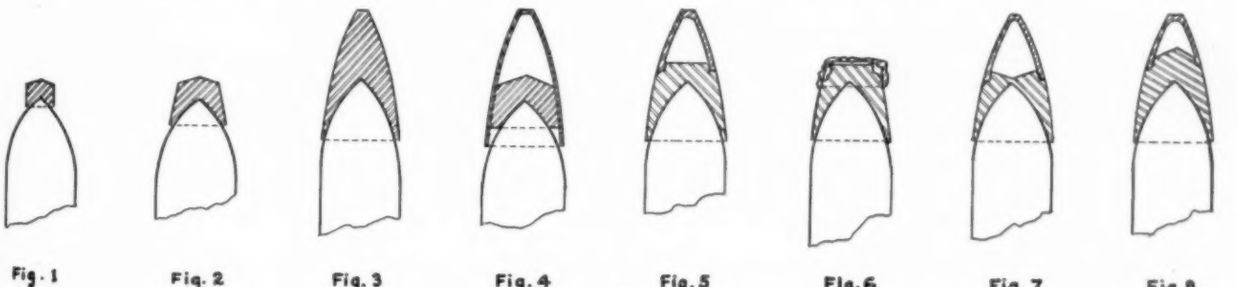


Fig. 1 Fig. 2 Fig. 3 Fig. 4 Fig. 5 Fig. 6 Fig. 7 Fig. 8

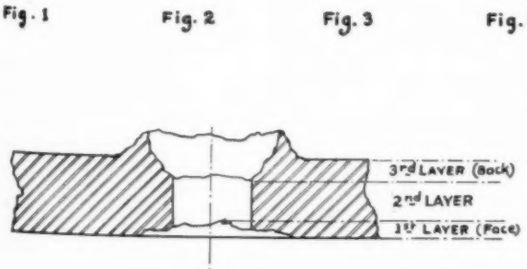


Fig. 9

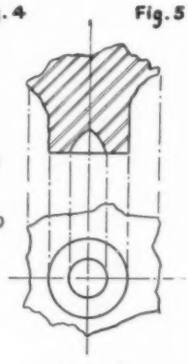


Fig. 10

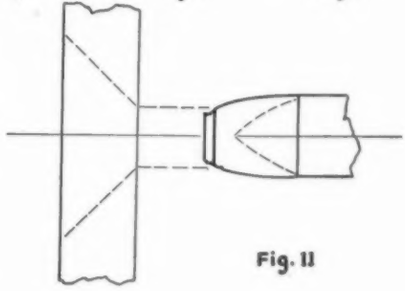


Fig. 11

Types of Caps on Armor-Piercing Projectiles.

for the hollow tip. Cast iron was selected with the idea of having a brittle material which would break up quickly and scatter away from the point of impact. Results were very poor and it was thought that the particles of iron which did not fly away from the impact actually helped destroy the cap before it could function.

Results with a steel of .40 to .50 carbon were not much better, but when a soft ductile steel was used a fair percentage of success was obtained. Apparently the soft hollow tip flattened out, as shown in Fig. 6, leaving the cap in best condition to function properly. The result was comparable to a degree with the old type of cap. The armor-piercing qualities, however, were by no means perfect although greatly improved. The design was further modified within the narrow limits allowable to give the widest possible cap area at a point in section a fraction of an inch in front of the shell point. It was thought that a slight improvement was noticed. (Fig. 7.)

A new variable, the oblique test, was introduced at about this time resulting in an increase of erratic results, which led to a new series of experiments on heat treatment of the projectile.

The situation was soon again better in hand, however, as the result of information from England on the use of hardened alloy steel caps. Hardened caps had been in use for some time in Russia and in France so that the idea was not entirely new and had in fact been given several unsuccessful trials in this country. The new cap (Fig. 8), however, for which the Hadfields were responsible, was heat treated much more effectively than older designs. It was very hard in the section just in front of the projectile point and very tough on the skirt section. The extreme front end was a hollow tip similar to our own development of design.

This cap stands today with various minor modifications as the most efficient type of cap and is in a large measure responsible for our ability to pierce the present day armor at fairly wide oblique angles.

In studying the function of the cap, we are dealing with a performance requiring only a very small fraction of a second for completion, and a tremendous expenditure of energy. Our early conception of the need of a cap was apparently based on the fact that it is easier to push a needle into a sheet of metal when a piece of wood is placed in front of it to furnish support at the point of penetration. This explained the idea of trying soft steel or wrought iron as material for the cap. Early designs as explained above were much larger (Fig. 2) and heavier than is familiar to modern practice, and it is the writer's opinion that this heavy cap was a big factor in the success of shells now more than a decade old.

A theory which would account in part for the good performance of these old shells, and which seems to be consistent with developments of more recent date is verified by observation of plates and buttons which the proof officer usually has available for study.

When a Krupp cemented plate has been successfully pierced by an armor-piercing shell, certain characteristics of the plate and of the hole are generally noticed (Figs. 9 and 10). Flaking of the hardened face occurs on the front and varies in depth and extent with the hardness of the plate. The second layer shows a punched hole often smooth and well coppered, approximately the same diameter as the shell. The back is usually torn away in a heavy cone-shaped button. Sketch of a representative button (Fig. 10) shows imprint of the point of the shell which usually imbeds itself in the second layer to a depth of from two to four inches before punching the button.

The point starts punching action either after or during the flaking of the face metal and penetration progresses as the pressure of the projectile due to its great velocity shears out the button in front of the shell point, and the body of the shell forces its way through the plate causing the smooth hole in the second layer. The three layers of plate are of course in part imaginary, but are the best way to visualize the varying conditions of plate over its cross-section from front to back.

When a projectile attacks a plate with a hardened face, it has been observed that the cap lends lateral support to the point of the projectile while it forces its way through the first layer of plate. When the point has entered a short distance, the face being brittle is wedged away and breaks up, becoming useless. If the projectile has been tempered sufficiently to be tough enough to withstand the shock, and at the same time is hard, it will usually penetrate the second layer of plate by reason of its pointed form and concentration of energy on one small spot.

If the projectile were not capped, the hard face of the armor would break up its point and cause failure of the shell. This can be readily verified by comparison of capped and uncapped shells against the same plate at equal velocities. Hence it seems fair to assume that the cap performs the important duty of materially assisting in breaking up the face of the plate.

If it were not for the necessity of breaking up the face of the plate, the cap would probably be a detriment to the efficiency of the shell as it would distribute the energy of impact over a large area of plate, thus reducing the foot-pounds per square inch of striking energy and actually helping the plate to cushion the blow and distribute its effect with possible failure of the shell. Illustrating this point in another way, a soft plate (not usually available) capable of resisting flaking would probably keep out a capped projectile where an uncapped one would succeed.

What actually happens is in such a short interval of time and the destruction of the cap is so complete that direct conclusions are difficult to form except after accumulation of a sufficient number of results to justify them. Fragments of caps are seldom ever found of suitable size for study except for a few small pieces of the skirt. However it seems reasonable to suppose that there is a very small increment of time in which the cap actually is the cause of lines of vibration tending to rupture the plate somewhat as shown in Fig. 11 along lines of shearing stress at 45° from normal, and actually does cause primary fracture of the hard face layer of the plate resulting in the flaking away of this layer. In this exceedingly short instant, the work done probably is accomplished before or during deformation of the cap so that in effect it strikes the blow of a secondary projectile.

This seems to be substantiated by the great improvement shown in the past few years by projectiles fitted with hardened caps which apparently resist deformation for a

longer increment of time and hence more perfectly accomplish the work required.

What happens subsequently, we can only conjecture. Many believe that the soft metal cap acts as a lubricant for the punching action of the shell. This may or may not be, but whatever function it really does perform at this juncture is secondary in importance to the first blow which causes plate vibration. It is fairly certain that after the face of the plate is flaked off, the projectile proper does the balance of the work. It reaches the plate at just the instant when elasticity of the plate is under tension in a favorable direction and follows through.

Evidence is available that the plate is, in fact, bent backwards or bulged at the point of impact during passage of the shell. Careful measurement of the diameter of the hole will show that it is smaller than the bourrelet of the projectile. In extreme cases the hole has been found to be over 1/16-inch smaller on 12-inch and 14-inch tests. This of course is only of passing interest, but it proves there has been a bulging effect due to the impact of the shell and the resulting momentary strain rearward. It also points to a possible cause of failure of shells with the bourrelet too far to the rear on the shell body. Too great a distance of travel to the maximum shell diameter may allow a sufficient interval of time for the plate to recover its poise before the bourrelet is reached and in consequence would wire-draw the projectile and fracture its base.

WILLIAM HERBERT KEEN,
Maj. Ord. Res., U. S. A.

Fundamental Properties of Military High Explosives

THE general term, "explosive," may be applied to all chemical compounds or mixtures of compounds, which can be decomposed in a very short time and which upon decomposition evolve heat and yield gaseous products. However, the fact that a given compound or mixture meets this definition does not imply necessarily that it would be suitable for use as a military explosive. Without considering the very important elements of availability and cost, any explosive that is at all acceptable for military purposes, must possess certain well defined properties which will accurately balance it against certain specific requirements.

If, for example, the case of an explosive for use in loading artillery shell be considered, the specific requirements might be established as follows:

1. The explosive must not undergo any change from its original condition upon long storage at either high or low atmospheric temperatures.

2. The explosive must be capable of withstanding the shocks that are inherently incident to the loading and transportation of the shell, and to the firing of them from the gun.

3. The explosive must be capable of detonating completely under the action of a comparatively small amount of booster or priming explosive.

4. The explosive upon complete detonation must be capable not only of rupturing the shell but of reducing it to fragments, fairly uniform in number and size.

In addition to the above requirements, others are usually established in order that the explosive may conform to standard methods of loading. For example, it may be required that the explosive have a melting point sufficiently low that it can be fused at temperatures obtainable with low pressure steam, in order that the charge may be cast into the shell. And further it may be required that the explosive shall not react with iron or steel, to avoid corrosion of the interior walls of the shell and consequent contamination of the charge with the corrosion products. These last mentioned requirements, although of much importance, are not fundamental, however, for such features of an explosive as high melting point and reactivity with metals can be overcome by employing special methods in loading the shell. As a matter of fact Explosive D is an explosive of this type, since it cannot be loaded by casting and is reactive with iron and steel, yet it has been used with quite satisfactory results. Amatol, as used by the British and the United States in the past war, is another explosive which meets all fundamental requirements for a shell charge but does not possess all of the features that may be considered desirable.

In determining by tests whether a given explosive will meet the requirements listed above as fundamental, the following properties of the explosive must receive consideration: 1, stability; 2, sensitivity to impact or shock; 3, sensitivity to detonation by means of initiators; 4, brisance.

The term stability refers to the capacity of an explosive to retain its chemical and physical properties unaltered during an indefinite period under normal conditions of storage. As it is impossible to obtain within a reasonable time accurate data as to the stability of an explosive whose properties are unknown, by conducting periodic tests on it in storage, the expedient is followed in investigative work of noting the action of the explosive under temperatures appreciably higher than the maximum obtainable under service storage conditions. A number of special stability tests have been devised for this purpose but practically all are based on the general principle that the rate of a chemical reaction increases with the temperature. Decomposition of an explosive being a chemical reaction, it is only necessary to determine the *length of time* that is required for measurable decomposition to occur at some more or less arbitrarily established temperature. Another scheme that is used involves the determination of the *amount of decomposition products* which result from heating the explosive at a given temperature for a given time. In either case it is of course necessary to compare the results with those obtained by the same method on some standard explosive whose stability has been established by actual demonstration of its capacity to withstand long periods of storage under ordinary conditions.

Sensitivity to impact or shock refers to the ease with which an explosive can be detonated by the sudden application of mechanical force. It is generally true that sensitivity is not only a function of the amount of force that may be applied to a given explosive without causing detonation, but is also a function of the rate at which the force may be applied. For example a pressure of 125,000 lbs. per sq. in. can be slowly applied in loading mercury fulminate or lead azide into a metal component, without causing detonation of either of these sensitive explosives, but if only a small fraction of this force be suddenly ap-

plied, as might be done by a sharp blow with a hammer, the explosive will detonate readily.

Determination of the sensitivity of an explosive, therefore, does not involve so much the measurement of the amount of mechanical force that is required to effect detonation, as it does the determination of the effect of a sudden application of some arbitrarily established force The drop test which is widely used as a means of determining sensitivity involves the measurement of the minimum height which a given weight must fall in order to produce detonation of the explosive in question when it is confined in a standard manner. By comparing the different heights of fall required for the weight to cause detonation of various explosives, a comparative value for the sensitivity of each explosive can be obtained.

Another test which has been used considerably consists in firing a rifle bullet from a definite distance into a pasteboard or metal container filled with the explosive the sensitivity of which is in question. Here again it is necessary to know the action of a number of standard explosives in the test in order that definite information as to the sensitivity of the explosive can be obtained.

Sensitivity to detonation is ordinarily expressed in terms of the amount of mercury fulminate required to effect complete detonation of an explosive under a given set of conditions. The sand test is perhaps the most common test for this purpose. It involves pressing a definite weight of the explosive into a copper capsule of definite dimensions. Various amounts of mercury fulminate are placed above the explosive charge and pressed into intimate contact with the base charge. The caps are then surrounded by sand, granulated between 20 and 30 mesh, in a bomb of definite capacity and fired. Complete detonation is indicated by the amount of sand crushed finer than 30 mesh. The minimum amount of fulminate required to give complete detonation consistently is taken as an index of the sensitivity of the explosive.

Some explosives are so insensitive that they cannot be detonated completely by mercury fulminate. In this case the sensitivity is usually expressed in terms of the minimum amount of tetryl required to effect detonation.

By means of the sand test it can be judged quite accurately whether an explosive is suitable, in so far as sensitivity is concerned, for a given purpose, i. e. as a booster charge, charge for armor-piercing shell, etc.

Brisance refers to the capacity of an explosive upon detonation to *shatter* any medium that may confine it. This property is quite different from the power or strength of an explosive, since the latter refer merely to the ability of the explosive to *displace* the medium which confines it. Power is dependent largely upon the amount of gas evolved and the temperature given off during explosion, whereas brisance depends more on the speed with which the explosion or detonation occurs. Black powder, for instance, is a fairly powerful explosive because of the amount of gas which it evolves upon explosion, but its brisance is very low because of the low rate at which the explosion occurs.

While rate of detonation determinations will indicate quite accurately the brisance of an explosive, the most practical test is the fragmentation test as carried out at Picatinny Arsenal. In this latter test the explosive is loaded into a standard metal container such as a 75 m/m or 155 m/m shell and exploded by means of the regular booster system, in a large chamber filled with sand. The number of fragments into which the shell is broken by a given explosive when compared with the number obtained from a standard explosive such as TNT, will indicate in practical terms the relative brisance of the explosive.

The degree to which a military explosive must possess the fundamental properties discussed above, depends to a great extent upon the purpose for which the explosive is intended. But for any particular purpose, it is only possible for the properties to vary within fairly narrow limits.

For instance, in choosing an explosive for use as a booster charge it is imperative that it be sufficiently sensitive that it will detonate under the action of mercury fulminate yet it must not be so sensitive that it will be liable to detonate from the shock incident to firing the shell from the gun. The explosive should also be highly brisant, more so than if it were to be used as a charge for shell, since the capacity of the booster explosive to initiate detonation of the shell charge is dependent largely on this property of brisance.

It is therefore very important in designing an explosive system such as fuze, booster and shell, or fuze, booster and bomb, that each component be provided with an explosive that is consonant with the others of the system, in order that the detonation of a very small amount of explosive in the fuze shall transmit detonation to the booster charge and the latter then be capable of effecting complete detonation of the shell charge. If a sufficient margin of safety is not allowed in adjusting one explosive to the other in the system, a comparatively slight variation in the loading density or in the quality of the explosive used, will cause erratic functioning or perhaps complete failures, when the system is used in the Service.

G. C. HALE,
Picatinny Arsenal.

Army Motor Transport Under Test

THE capabilities and limitations of motor transportation for Army use will be tested in future maneuvers and the larger tactical exercises conducted by the Army, the War Department announced in a recent statement:

"In conducting future maneuvers and larger tactical exercises the War Department will include therein problems and exercises which will test the capabilities and limitations of motor transportation in the movement of troops, equipment, material, and animals, including small Cavalry units. Motive power for field and combat trains, and light artillery, now mostly animal-drawn, will be put to exhaustive tests on all kinds of terrain.

"It is contemplated that in two-sided exercises one side will use normal animal-drawn transportation and the other use motor-propelled equipment and material. These tests will bring out the comparative capacity, usefulness and endurance of the two types of transportation.

"In connection with the September maneuvers of the First Cavalry Division, to be held in the vicinity of Marfa, Tex., the War Department has instructed the Commanding General, Eighth Corps Area, with headquarters at Fort Sam Houston, Tex., to arrange the maneuvers so as to permit careful study and tests involving the problems outlined above.

Personnel

Promotion, Separation and Reappointment of Reserve Officers

REVISED policies governing the appointment, promotion, assignment, separation and reappointment of members of the Officers' Reserve Corps, have recently been made public by the War Department. The regulations as revised are reprinted in part as follows:

PROMOTION

1. A reserve officer who is eligible for assignment or active duty training in the Officers' Reserve Corps in peace time may be promoted provided—

a. He holds a certificate of capacity indicating his professional qualification or has, during the five years immediately preceding, demonstrated his interest in military affairs by having a written record of at least 300 hours of correspondence school work, attendance at classes, administrative duties in connection with his unit, or active participation with troops on inactive duty training. In computing the 300 hours, each 15-day period of active duty will be considered as 100 hours for credit; and

b. There is an appropriate vacancy in the grade and section in the corps area, branch, or activity allotment under such peace-time procurement objective as the War Department may establish, and

c. He shall have served a minimum time in grade in the Officers' Reserve Corps as constituted under Section 37, National Defense Act, as follows:

As a Second Lieutenant	3 years
As a First Lieutenant	4 years
As a Captain	5 years
As a Major	6 years
As a Lieut. Colonel	7 years

An officer who is not eligible for assignment or active duty training is not eligible for promotion.

No officer will be promoted or appointed to any grade in the Officers' Reserve Corps higher than that of a Major unless he first shall have completed the full course of instruction required of Regular Army officers at the Special Service Schools of his section and the full course as required of Regular Army officers at the Command and General Staff School or shall have passed such special examinations as the Secretary of War may direct provided that this restriction will not apply in the case of promotion of any Reserve officer who has had World War experience as an officer.

SEPARATION

1. Appointments in the Officers' Reserve Corps are terminated by death, resignation, vacation of appointment (by virtue of accepting commission in the Regular Army or acceptance of an appointment in a different grade in the Officers' Reserve Corps), discharge, expiration of term of appointment, and dismissal or dropping from the rolls.

2. Any reserve officer may be discharged at any time in the discretion of the President. Discharge will be the form of separation in cases not otherwise covered, including the following:

a. Incompatible occupation of office. This will include an enlistment or the acceptance of a commission in the United States Navy, Marine Corps, Coast Guard, Naval Reserve or Revenue Cutter Service. Separation is mandatory.

b. Physical disqualification.

c. Misconduct, inefficiency, failure to reply to communications or other unfitness. In time of peace reports of misconduct, inefficiency, failure to reply to communications or other unfitness on the part of any reserve officer, will be forwarded to the Department or Corps Area Commander. The latter will cause such investigation to be made as is deemed necessary, or as directed by higher authority. Where the Department or Corps Area Commander deems it necessary, or upon the demand of the officer concerned the Department or Corps Area Commander will cause to be convened a suitable Board of not less than three officers to further investigate and make recommendations. The officer whose fitness is being inquired into will be informed of the alleged inefficiency, misconduct, or unfitness, and will be given opportunity for a hearing before the Board, either in person, by counsel, or by brief, as he may elect. One or more reserve officers on inactive status will be included in the membership of such boards. The Board's proceedings, together with the action and recommendations of the convening authority will be forwarded to the War Department for final action.

REAPPOINTMENT

1. *a.* When the five-year period of appointment of a reserve officer above the grade of captain expires, he will not be eligible for further assignment or active duty training in the Officers' Reserve Corps in time of peace unless it has been officially recorded during the said five-year period that—

(1) He has obtained during his current appointment a certificate of capacity for promotion to the next higher grade; or

(2) He has during his current appointment obtained a certificate of capacity for his present grade; or

(3) He has demonstrated during his current appointment his interest in military affairs by having a written record of at least 200 hours of correspondence school work, attendance at classes, administrative duties in connection with his unit, or active participation with troops on inactive duty training. In computing the 200 hours, each 15-day period of active duty will be computed as 100 hours for credit; or

(4) He has satisfactorily completed during his current appointment the prescribed correspondence course of instruction for reserve officers at the Special Service Schools of his branch or the special course for reserve officers at the Command and General Staff School or the Army War College or a full course at one of the above mentioned schools; or

(5) The Chief of Branch certifies that he has performed work equivalent to (3) above.

b. The provisions of paragraph 1, *a*, do not serve to prohibit the reappointment of any reserve officer in the section in which previously commissioned. Any person, appointed in the Officers' Reserve Corps subsequent to the approval of those policies, and who has had prior service in the Officers' Reserve Corps, will be allowed all the privileges of assignment and active duty training during his first appointment; subsequent appointment will be governed by the provisions of this policy.

2. *a*. When the five-year period of appointment of a reserve officer in the grade of captain or lieutenant expires, he will not be eligible for assignment or active duty training in peace time during the five-year period of appointmment immediately following unless his record during the five-year period immediately preceding such reappointment indicates that

(1) He has obtained during his current appointment a certificate of capacity for promotion to the next higher grade; or

(2) He has during his current appointment obtained a certificate of capacity for his present grade; or

(3) He has demonstrated during his current appointment his interest in military affairs by having a written record of at least 200 hours of correspondence school work, attendance at classes, administrative duties in connection with his unit, or active participation with troops on inactive duty training. In computing the 200 hours, each 15-day period of active duty will be considered as 100 hours for credit; or

(4) He has satisfactorily completed during his current appointment the prescribed correspondence course of instruction for reserve officers at the Special Service Schools of his branch or the special course for reserve officers at the Command and General Staff School or the Army War College or a full course at one of the above mentioned schools.

b. Any reserve officer in the grade of captain or lieutenant who upon the termination of a 5-year period of appointment has not during that period been eligible for assignment or active duty training, or who has not fulfilled the requirements of 2, *a*, above, may, upon his own request and upon the recommendation of a board of reserve officers appointed by the corps area or department commander and approved by the War Department, be reappointed without physical examination in the grade and section of the Officers' Reserve Corps in which he was previously commissioned; otherwise he will be honorably discharged from the Officers' Reserve Corps.

3. In putting this policy into effect, and until a 5-year period has elapsed, only the portion of the work required by paragraph 1, *a*, (3) and 2, *a*, (3) which corresponds to the ratio of hours to elapsed time will be required in making decisions as to status during next reappointment period.

4. For the purpose of recommending the separations from the service of officers no longer in a position to be effective and to advise the corps area commander concerning the administration of Reserve policies, a corps area Advisory Board of Reserve Officers will be created in each corps area. This board will be permanent in character, but will have a continuing change in personnel. Its members will serve on an inactive duty status.

5. This policy will govern all reappointments which will be effective on or after January 1, 1928, except that the instructions announced in letter from this office dated April 21, 1927, regarding physical examinations for field officers for reappointments effective on or after July 1, 1927, remain in effect.

6. Transfers to the Unassigned Section will be discontinued. As soon as practicable reserve officers now in that section will be transferred to the Auxiliary Section.

7. In determining, under paragraph 4 above, the pro rata requirements of paragraphs 1, *a* (3), and 2, *a*, (3) above, for reappointments effective during the calendar year 1928, an allowance of ten hours for reserve officers residing within the continental limits of the United States and an allowance of fifteen hours for those residing outside the continental limits of the United States, will be made to compensate for the time necessary to notify reserve officers of these requirements and for the period required for advance reports as to qualifications for reappointment.

Recently Commissioned Ordnance Reserve Officers

THE following reserve officers have accepted appointments in the Ordnance Department Reserve since the last issue of ARMY ORDNANCE:

2nd Lieut. George W. Beckman, Ord. Res., 1737 Clauser St., Hellerton, Pa.

2nd Lieut. Norman R. Benham, Ord. Res., 8020 Dexter Blvd., Detroit, Mich.

2nd Lieut. Leonard Boddy, Ord. Res., 2209 Chestnut St., Erie, Pa.

2nd Lieut. Max A. Brackett, Ord. Res., Elk Mound, Wis.

2nd Lieut. Richard S. Brown, Ord. Res., 3460 Chevoit Ave., Cincinnati, Ohio.

2nd Lieut. Rudolph M. Bush, Ord. Res., 922 F St., N. W., Washington, D. C.

2nd Lieut. Charles T. Carnahan, Ord. Res., 1132 Kensington Road, Los Angeles, Calif.

2nd Lieut. Delmar G. Cochran, Ord. Res., 663 Ross Ave., Hamilton, Ohio.

2nd Lieut. Gaillard W. Dell, Ord. Res., Sand Lake, Mich.

2nd Lieut. Paul W. Dorst, Ord. Res., 523 Terrace Ave., Cincinnati, Ohio.

2nd Lieut. Thomas C. Duncan, Ord. Res., 116 Richey Ave., Pittsburgh, Pa.
2nd Lieut. Schuyler B. Elliott, Ord. Res., 8808 Carnegie Ave., Cleveland, Ohio.
2nd Lieut. Paul C. Ely, Ord. Res., 100 McKee Ave., Monessen, Pa.
2nd Lieut. Robert L. Ennis, Ord. Res., Arcade, N. Y.
2nd Lieut. William F. Gallagher, Ord. Res., 74 Orange St., Hartford, Conn.
2nd Lieut. Harold F. Heinzelman, Ord. Res., 761 East 231st St., New York, N. Y.
2nd Lieut. Joel C. Hertsche, Jr., Ord. Res., 781 E. 24th St., North, Portland, Ore.
2nd Lieut. Edgar F. Heselbarth, Ord. Res., Washington Pike, Greenridge Farms, Crafton Branch, Pittsburgh, Pa.
2nd Lieut. Samuel A. Huffman, Ord. Res., 652 Probasco St., Cincinnati, Ohio.
2nd Lieut. Arthur W. Lewis, Ord. Res., 18 Tilton Ave., Oneonta, N. Y.
2nd Lieut. George M. Little, Ord. Res., 902 Rockton Ave., Rockford, Ill.
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2nd Lieut. Albert W. Nevers, Ord. Res., 266 Bowdoin St., Winthrop, Mass.
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2nd Lieut. August W. Rickenbach, Ord. Res., Box 424, Punta Gorda, Fla.
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2nd Lieut. William F. Schanzle, Ord. Res., 2407 Kenton St., Cincinnati, Ohio.
2nd Lieut. Harry Schmidt, Ord. Res., Ordnance Specialists' School, Raritan Arsenal, Metuchen, N. J.
2nd Lieut. Hugh M. Smith, Ord. Res., 1258 South High St., Denver, Colo.
2nd Lieut. Norman S. Spatz, Ord. Res., Route No. 1, Bernville, Berks Co., Pa.
2nd Lieut. Frank C. Staples, Ord. Res., 1238 Warren Ave., Campello, Mass.
2nd Lieut. Herbert G. Stermer, Ord. Res., 418 South St., Mauch Chunk, Pa.
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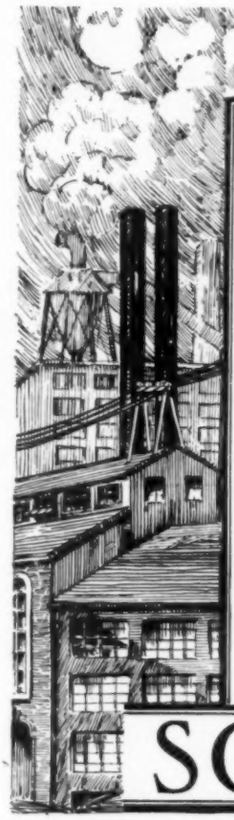

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Patents

Brief Descriptions of Inventions of Interest to Ordnance Engineers

Compiled by W. N. Roach, Chief, Patent Section, Office of the Chief of Ordnance

Ammunition

THE following are some recent patents relating to ammunition:

Maj. Cecil G. Young, Ord. Dept., U. S. A., has been granted patent No. 1,633,656, for an apparatus for filling containers with explosives. The principal object of this invention is to provide a device by means of which containers, particularly bombs and shells, may be filled with explosive in such a manner as to provide a cavity of accurate shape and dimensions for receiving an adapter and booster casing, thereby avoiding the necessity of subsequently drilling out the explosive after cooling.

Patent No. 1,633,710 has been granted to Henry Newton, for a trench mortar and similar devices. The main object of the invention is the provision of a charge for trench mortars or other low pressure guns made of a plurality of separate and distinct parts, one or more primer charges and one or more secondary charges, the primer charge or charges burning rapidly and thereby creating a temperature and pressure environment proper to insure the complete combustion of the secondary charge or charges. The primer charge or charges may be confined in a combustion chamber provided upon the base of the projectile and having ports for the emission of the propellant gases.

Patent No. 1,634,953 has been granted to Milo McCune and Chas. L. Paulus, of McCook Field, for a cartridge rack. The main objects of this invention are to provide a rack formed of one piece of metal and also to provide means for carrying pyrotechnic ammunition or other ammunition of a like nature in such a way that it is always readily available for use.

Frank H. Bergeim, assignor to E. I. du Pont de Nemours & Co., has been granted patent No. 1,637,726, for a process for producing explosives. The main object of the invention is to provide a process by means of which aliphatic oxides may be nitrated in an advantageous manner so as to avoid the disadvantages hitherto inherent in connection therewith. The desired results are obtained by using a diluent such as ethylene glycol, or glycerol, and then nitrating the ethylene oxide with nitric and sulphuric acid.

Valentin Schlafer, assignor to Rheinische Metallwaaren- und Maschinenfabrik, has been granted patent No. 1,637,964, for a fuze for projectiles. The main object of this invention is the provision of a time train fuze to the interior of which air may be admitted at the beginning of the flight of the fuze.

Artillery

The following are some recent patents relating to artillery:

John M. Strang, assignor to Barr & Stroud, Ltd., has been granted patent No. 1,634,395, for an eye-piece prism combination for use in range finders of the self-contained base type. In this eye-piece prism the beam of light from one (or in some cases, both) of the telescope systems is reflected from three surfaces in succession, two of which are parallel to each other and perpendicular to the third, these parallel surfaces being each contiguous to the third surface and parallel or substantially parallel to the plane of triangulation, the third surface being perpendicular to the plane of triangulation and inclined at an angle of 45° to the base of the range finder. These three surfaces divide the beam, reflect divided parts of the beam differently, in regard to order of reflection, and cause the parts reflected to unite and reform the beam. Thus, part of the beam may be reflected first from the perpendicular surface and then from the two parallel surfaces, while the remainder of the beam is reflected from one of the parallel surfaces first, then from the perpendicular surface and then from the second parallel surface. In some cases two parts of the beam may be reflected as above, while the third part is reflected from both of the parallel surfaces before reflection at the perpendicular surface. To prevent splitting of the image by this division of the beam and these different orders of reflection, it is essential that the two first named reflecting surfaces should be parallel to each other and perpendicular to the third surface. Advantages of this arrangement are that it reduces the amount of space required for the two total internal reflections in the prism, the length of path of the rays in the glass of the prism is reduced without introducing any silvered reflecting surfaces, and greater freedom is provided for the design of the prisms since the division of the reflection of the beam at the three surfaces can be varied according to requirements.

Capt. James C. Karnes, Ord. Res., U. S. A., of the Office of the Chief of Ordnance, has been granted patent No. 1,635,365, for a fire-control system for guns. This system is adapted for use principally in antiaircraft fire and the

main object of the invention is to synchronize the azimuth, elevation, fuze-setting and firing mechanisms.

Patent No. 1,635,763 has been granted to Clemens Otto, assignor to Firm Rheinische Metallwaaren-und Maschinenfabrik, for a gun sighting device. The main object of the invention is the provision of means for obviating the effect of inclination of the trunnions.

Capt. Elmer C. Goebert, Ord. Dept., U. S. A., has been granted patent No. 1,636,128, for a fastening device for gun shields. The invention aims to provide a latch for shields of gun carriages which will hold the shield in adjusted position against rattling without any additional securing means.

Nicolas E. Methlin, assignor to Schneider et Cie., has been granted patent No. 1,634,754 for a gun barrel. This invention contemplates the provision of a gun barrel provided with a jacket towards its rear portion, the barrel screwed into the jacket with a clearance between the barrel and jacket, the elastic limit of the barrel being such that no permanent set will be caused in the barrel due to firing so that the same may be readily removed from the jacket at all times.

Small Arms

The following patents relate to small arms:

Patent No. 1,635,059 for gun sights for night use has been granted to Herbert O. Russell and Chas. L. Paulus of McCook Field. According to this invention there is provided a sight adapted to project a ray of light upon a target.

Patent No. 1,636,357 for an anticlimb device, has been granted to Richard M. Cutts, Jr., assignor to Richard M. Cutts, Sr. The main object of the invention is the provision of a muzzle attachment for a gun designed to steady the muzzle of the gun during firing.

Capt. James L. Hatcher, Ord. Dept., U. S. A., has been granted patent No. 1,636,509, for a receiver sight for rifles. The invention aims to provide a sight which may be mounted readily on the receiver of the usual service rifle and with little or no change in construction of the receiver and which will place the sight in a more convenient position with relation to the eye of the user of the rifle.

Geo. Norman, assignor to Birmingham Small Arms Co., Ltd., has been granted patent No. 1,637,233, for small arms. The main objects of this invention are provisions of improved means for effecting the rotary locking movement of the breech bolt; for covering the opening in the receiver when the bolt is in its forward or closed position, such means being adapted to permit the manual operation of the gun; and to dispense with the opening slots or gaps in the receiver or breech body which are usually employed to control reciprocating movement and to effect rotary movement of the breech bolt.

The same inventor has been granted patent No. 1,637,234 for an automatic firearm. The main object of this invention is the provision of a safety device.

Mr. Norman also has been granted patent No. 1,637,235 for an automatic firearm. This invention covers a specific form of bolt. The same inventor has also been granted patent No. 1,637,236, which invention relates to a specific form of trigger guard.

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Books

Life in a Man-of-War—Scenes in "Old Ironsides" During Her Cruise in the Pacific. By A Fore-Top-Man. Preface by Rear Adm. Elliot Snow, C. C., U. S. N. Boston: Houghton Mifflin Company. 1927. $10.00.

AT A TIME when public interest in the restoration of *Old Ironsides* is at such a height, Admiral Snow has done a very commendable piece of work in making available this curiously interesting volume which, other than the Admiral's fascinating preface, is a verbatim reprint of the original edition of 1841, the author of which hid his identity under the *nom de plume*, "A Fore-top-man" on that historic vessel. The Admiral, whose painstaking research in this field was exemplified in ARMY ORDNANCE some months ago in his contribution "The Battery of Old Ironsides," after accurate deduction makes out the author to be one Henry J. Mereier.

Hugo's "Toilers of the Sea" and Dana's "Two Years Before the Mast" have more romance, "H. M. S. Pinafore" is a greater satire, but "Life in a Man-of-War" so smacks of the salty traditions, the nautical sense of humor, and the hardy seamanship so long the glory of the American Navy that it bids fair to take its place in the tradition of our maratine development.

The New International Year Book, 1926. Edited by Herbert Treadwell Wade. New York: Dodd, Mead and Company. 1927.

MAJ. Herbert Treadwell Wade, Ord. Res., U. S. A., has performed another very valuable public service in producing the latest volume of The New International Year Book, that for the year 1926. Major Wade will be remembered by many members of the Army Ordnance Association as the progenitor of the *Handbook of Ordnance Data*, that indispensable bible of 1918, which was compiled under his direction.

This is the twenty-fifth issue of an unbroken series of annual records begun in 1898 presenting in "convenient and acceptable form a chronicle of the more important phases of human activity." Little of interest to anyone seems to have escaped the watchful eye of the editor.

The article on Military Progress was prepared by Col. John J. Bradley, Inf., U. S. A., who presents a very readable account of things military during the past year. For instance, such live subjects as the production of projectiles from seamless tubing, the adoption as standards of the medium and heavy tractors, and the transcontinental test of the 14-inch railway gun, are discussed. The same thoroughness marks the treatment of other military subjects and indeed, it seems, the myriad of other titles as well.

History of the Explosives Industry in America. By Arthur Pine VanGelder and Hugo Schlatter. With an Introduction by Dr. Charles E. Munroe. New York: Columbia University Press. 1927. $10.00.

THE Institute of Makers of Explosives, through the sterling work of Messrs. VanGelder and Schlatter, has sponsored an extremely worth while undertaking in making possible this valuable history.

To present a succinct résumé of the development of explosives by the dean of explosives in America, Dr. Charles E. Munroe, is a real service in itself. But to combine with this an accurate and thorough narrative of the growth of the explosives industry in our country is to produce a monumental work of vast significance. This the authors of the volume in hand have done, and they have done it well.

Of particular interest are the portions of the work devoted to the military and naval phases of explosives development. The chapters on Smokeless Powders in the United States Navy and Smokeless Powders in the United States Army, together with Part V, Military Explosives, comprise a compendium of data on these topics unexcelled in print anywhere.

The painstaking energy of the authors, the wholehearted support of the Institute, and the obviously generous assistance of the multitude of individuals who helped furnish the information here collected, lay heavy claim on all interested readers to have a personal copy of this historical masterpiece on the American explosives industry.

A Greater Than Napoleon: Scipio Africanus. By Captain B. H. Liddell Hart. Boston: Little, Brown and Company. 1927. $3.50.

CAPTAIN Hart has made out an excellent case in justification of the title he has given his study of the career of Scipio Africanus. While greatest emphasis is

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naturally laid on the military side of his activities, there is ample evidence of Scipio's preeminence as a statesman, his nobility of character, his keen perception of psychological values, and his culture, which show him to be unique among the great soldiers of all times.

The various campaigns in Spain, Africa, and finally against Antiochus across the Hellespont are brilliantly related, and adequate maps illustrate the tactics of the engagements. One of the most interesting, readable, and best written of military histories, this book should be included in the library of all who have the slightest interest in such matters.

Exploring the Universe. The Incredible Discoveries of Recent Science. By Henshaw Ward. Indianapolis: The Bobbs-Merrill Company. 1927.

ASTRONOMY in recent years has revealed a universe of awe-inspiring proportions, but at the other end of the scale Mr. Ward shows us the unit of life, the cell, as equally marvelous. The erudite author has astonishing skill in presenting scientific facts so that they are comprehensible to the layman. He first takes the reader on a journey into the inconceivable vastness of space in an opening chapter on astronomy. Time is magnified to incredible periods in the succeeding chapter on geology. In the final chapter we learn what the theory of relativity, if true, will do to our conceptions of time and space. Between the opening and closing chapters is a field of exploration concerning recent discoveries in the various sciences that should be known by the educated man. This book affords a most excellent opportunity to get abreast of the times in the fields it covers.

The Mathematics of Engineering. By Ralph E. Root, Ph. D. Baltimore: The Williams and Wilkins Company. 1927. $7.50.

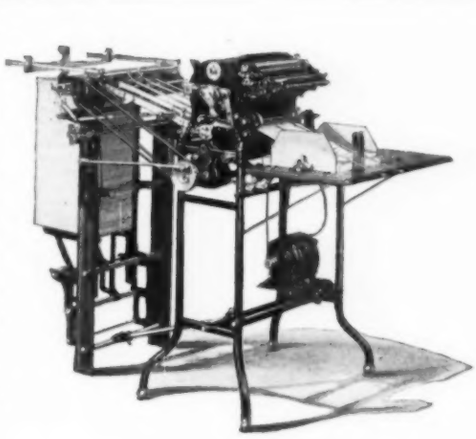
THE avowed purpose of this book to provide a course of study that will meet the mathematical requirements of the modern engineer seems to be accomplished in a very satisfactory manner. The author is professor of mathematics and mechanics at the post-graduate school of the United States Naval Academy, and the book is the result of many years of teaching in preparation for advanced engineering work.

The contents include every phase of mathematics required by the practical engineer. The chapter on the treatment of empirical data is an especially useful contribution. While primarily a text book, there is a field of considerable usefulness for this book as a reference manual for the practical engineer.

The Famine in Soviet Russia, 1919-1923. By H. H. Fisher, Chief of the Historical Department, the American Relief Administration; Lecturer in History, Stanford University. New York: The Macmillan Company. 1927. $5.00.

". . . . it was discovered that the murderer had cut up the body of his victim, and sold the flesh to a Persian, who in turn had sold it in the bazaar. This case resulted in the issuance of an order by the city authorities forbidding the sale of meat balls, cutlets, and all forms of hashed meats."

By employing as above the human interest factor this history of the American Relief Administration operations has been made most readable; in fact, it is as gripping



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as a romance. Combined with attractive style there is technical detail which makes the book advantageous in connection with the administration of extensive and scattered projects. Should you peruse this enthusiastic volume, see whether you can find sufficient justification for the solicitous fattening of the Russian Bear during the very time the Soviets were exporting grain. The question naturally arises, did Hoover sufficiently "Hooverize" on charity?

Morrow's Word Finder. By Paul D. Hugon. New York: William Morrow and Co. 1927. $4.00.

THE author presents a new departure in word books which combines many of the important features of the dictionary and thesaurus. By a system of interrelation of ideas and by cross references a desired word is readily found. While not complete, it is quite comprehensive and constant use should enable the user appreciably to enlarge his vocabulary. Much concerning word origins, rules of grammar, principles of rhetoric and pronunciation adds to its value as a reference book. A complete understanding of the manner of presenting the vast amount of information is necessary in order to obtain the maximum benefit and by systematic use and with one idea leading on to further investigation one should quickly learn to use it advantageously.

The Peacemakers of 1864. By Edward C. Kirkland. New York: The Macmillan Co. 1927. $2.50.

PROFESSOR Kirkland in the present volume throws new light on many of the interesting personalities and involved policies which were of great importance to the leaders of both the North and the South during 1864. The characters range from such steadfast and purposeful men as Jefferson Davis and Abraham Lincoln to the three Blairs, Horace Greeley and many of lesser importance, some being quite notorious. The morale of the military and civilian population of the North is clearly shown together with the struggle and importance of keeping the majority of its population in sympathy with and supporting its conduct of the war. The important influence exerted by politics and the public press is clearly and thoroughly presented and aids greatly in obtaining a clear understanding of the events and governing influences of this critical period of our history. The extensive bibliography should be a great aid to the student of history.

The Spell of the Caribbean Islands. By Archie Bell. Boston: L. C. Page and Company. 1926. $3.75.

TRAVEL through the Leeward and Windward Islands on a vessel which stops at the more important ports to discharge and receive cargo and thus allows time for the venturesome passenger to go ashore and delve for hours or days into the customs and habits of the inhabitants naturally causes certain impressions to be carried away by the traveler. Such impressions, written in an entertaining manner and with many interesting historical and bibliographical references concerning these Islands are here presented. We see at our front door a world which has not yet been spoiled by commercialism and where the rush and hurry of American urban life has no counterpart.

The delightfulness of the tropical climate, food, vegetation, and customs are faithfully portrayed. A little too much space is devoted to the poorer classes, leaving out of the picture almost entirely the more well-to-do. However, the masses represent the people, and undoubtedly the masses are poor, very poor.

Pheasant Jungles. By William Beebe. New York: G. P. Putnam's Sons. 1926. $3.00.

THE author spent seventeen months in the Far East gathering material for a monograph on pheasants which has already been published. This quest led him into Ceylon, upper India, Burma and Borneo. The scientific results of the expedition have previously appeared. This volume has to do with the author's adventures as he stalked rare pheasants through the forests of the Himalayas, and along the Malayan rivers. It deals with the natives with whom he worked, the country through which he hunted, and is filled with vivid descriptions of natural phenomena observed.

Taschenbuch Der Tanks. By Dr. Fritz Heigl. Munich: J. F. Lehmanns Verlag. 1926.

DR. FRITZ HEIGL, of Vienna, has gathered together in this volume of 182 pages, a compendium of characteristics of tanks as used and developed by the principal countries of the world. The book is illustrated with photographs and drawings.

Devoting the first part of the volume to tanks and tank armament of the World War period, the second portion is given over to descriptions of vehicles which are now standard in the several armies. The author has gathered together at the conclusion of the book a tabulation concerning characteristics of tanks in use by the various countries.